COCO-NUTS

THE CONSOLS OF THE EAST

WITH SPECIAL SECTIONS ON THEIR CULTIVATION IN

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AND

Some Original Sketches by F. A. G. PAPE

BY

H. HAMEL SMITH

Editor of "Tropical Life"; Author of "Notes on Soil and Plant Sanitation on Cacao and Rubber Estates"; "The Future of Cacao Planting"; "Cacao in the West Indies," &c., &c.

AND

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Fellow of the Royal Geographical Society; Fellow of the Royal Horticultural Society (B.E.A.); formerly Planter in Malaya, East Africa, Ceylon, &c.

SECOND EDITION

WITH FOREWORDS TO BOTH EDITIONS BY

SIR W. H. LEVER, BART.

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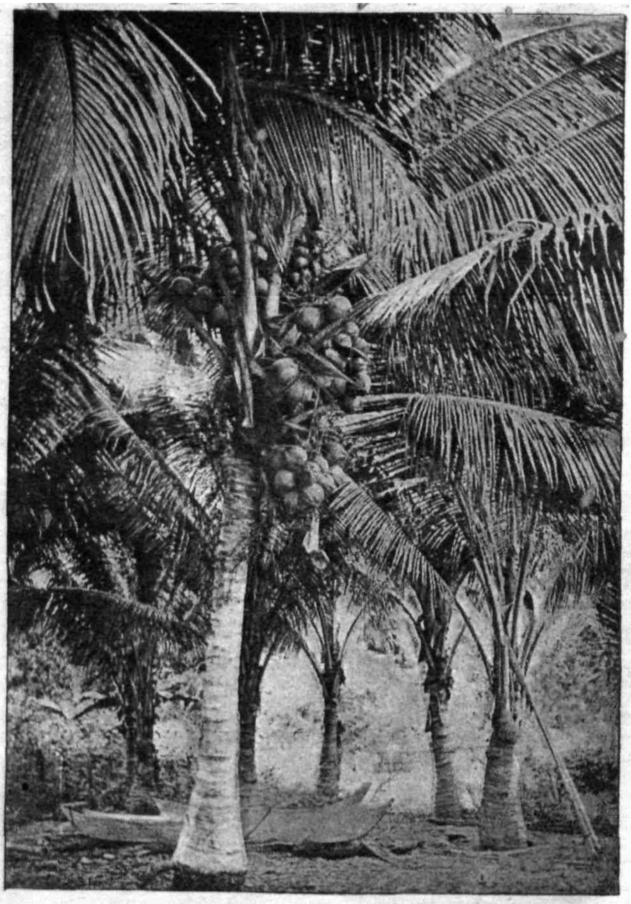

[Reproduced by "Tropical Life" from "Coco-nut Growing in the Philippines."]

A YOUNG COCO-NUT TREE FRUITING HEAVILY.

Other trees of the same age in the background are bearing no fruit, because they are set too close together. Their leaves form a fan-shaped mass instead of the hemisphere of foliage which is characteristic of the perfectly developed coco-nut tree.

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SIR WM. LEVER'S

FOREWORD TO THE SECOND EDITION.

AT Mr. Hamel Smith's request I take the opportunity offered by the issue of the second edition of this book to say a few words on the work it has done and the criticisms it has evoked. Under the first heading, judging from the lengthy reviews it has called forth, especially those of Mr. Bevan in the *Ceylon Observer*, there is no doubt that the book has attracted the attention of the planting world to what might be called the "side lines" or allied industries that can be evolved on large estates —say of 5,000 acres and upwards—if well managed. Partly on account of this, and of the book generally, the financial world has viewed the coco-nut planting industry generally as a much more favourable channel for investment than was the case twelve or eighteen months back, and the success of the first edition and the publication of a second issue will further encourage such attention to the "Cult of the Coco-nut;" an attention that will be as beneficial to the Tropics as it will prove advantageous to the wage-earners and food consumers over here.

At the same time no one can deny that the very care taken by Messrs. Hamel Smith and Pape to place the utilization of by-products of a coco-nut planting industry in a prominent light, so as to attract the desirable class of capitalist, has incited the more or less undesirable class of company promoter to seize the opportunity to make use of the book to exploit the public for their own ends and to quote only those portions which fit in with their tale to draw money from the pockets of the ignorant and careless investor, without including other facts that did not suit their purpose.

For instance, whilst all the prospectuses and other notices issued openly or as "private and confidential" prominently displayed the first sentence of my "Foreword" to the first edition (see p. xi), which runs as follows: "I know of no field of tropical agriculture that is so promising at the present moment as coco-nut planting, and I do not think in the whole world there is a promise of so lucrative an investment of time and money as in this industry," I noticed that not one included my expression of opinion that "the amount of capital required to become the possessor of a rich coco-nut plantation is not excessive, and should not exceed *£10* to *£12* per acre, including every expense except the planter's own labour and interest on capital." Grave exception has been taken to this estimate by those who have not read the Foreword care-

fully, or who wanted to value an acre of planted coco-nuts at *£25* to *£45* an acre and upwards. Such amounts are quite possible because they include cost of company promotion, vendor's profits, middlemen's commission, interest on capital, cost of management, &c., and also the price paid for the land and buildings, which I do not. This is distinctly shown by my stating "except the planter's own labour and interest on capital," the capital of course being needed to buy the land and erect the buildings, as well as to maintain the planter until his estate gives him some return. As I write, the Bulletin of the Department of Agriculture for Trinidad, July-December, 1912, which has come to hand, puts (on p. 173) the cost of clearing land to plant coco-nuts at 30s. an acre, and of roads, traces, lining, holing, planting seed-nuts, weeding and cutlassing and drainage at *£3* an acre—*£4 10s.* in all, leaving *£5 10s.* to *£7 10s.* per acre for cost of weeding and cultivation until the estate gives a return.

I was glad to see on my return from West Africa that Mr. Hamel Smith had not allowed the misuse of my Foreword to go by unchallenged, and that many of the papers, including the three leading financial papers, in London, published the following or a similar letter to this one taken from the *Liverpool Post* of February 26, 1913:—

A Boom in Coco-Nuts.

To the Editor of the "Post and Mercury."

"Sir,—Several prospectuses, advance notices, and other printed matter have come to my knowledge recently, from which I gather that an attempt is being made to educate the public up to a coming boom in coco-nuts. Some of the prospectuses, &c., contain quotations from my book, 'Coco-nuts—the Consols of the East,' particularly Sir W. H. Lever's 'Foreword' to it, and from articles in my paper, *Tropical Life*.

"Correspondents, in some cases perfect strangers to me, have brought the matter to my notice, and have asked me whether the statements are reliable and if I can recommend investment. Under these circumstances I ask the indulgence of your columns to state that in no case have I, or my publishers, been asked to give or given permission to use the extracts from my book or paper, and I would prefer that they should not do so; but my solicitors advise me that I cannot prevent such quotations from appearing.

"I would also warn your readers against relying on any short quotations from my book or paper without making themselves fully acquainted with the context; and would add that I have always been careful to warn my readers against relying on a larger annual

average crop than forty nuts per tree, or, at the most, fifty nuts from ten-year-old palms.

"Yours, &c.,

"H. HAMEL SMITH,

"Editor, *Tropical Life.*"

"112, *Fenchurch Street,*

"*London, E.C.,*

"*February* 24, 1913."

As with the first, this the second edition has my sincere good wishes; I hope it will have a wide circulation, especially among the planting fraternity abroad, and fall into the hands of those who will use it to benefit themselves as planters and producers, and not merely to exploit the public as was done in far too many cases in connection with the rubber boom. In order to express these wishes, I am making time on the eve of my departure (September 20) for Australia and the South Seas to add a second Foreword to the new edition to wish it "Good Luck."

Before concluding, I would like to add that strong as was the case for the profitable outlook of coco-nut planting when I wrote the Foreword to the first edition, it is stronger to-day. Copra has still further advanced and the prospects are that this advance has not yet reached its ultimate limit, owing to the fact that the oil from the coco-nut is found to make the most excellent vegetable butter that can be produced, equal in every way and in many

respects superior to natural cow butter. The price at which the vegetable butter can be sold, notwithstanding the present high price of copra, is less than half the price at which natural butter can be sold.

Thornton Manor,
Cheshire,
September 17, 1913.

of interest, the long wait and the accumulation of expenses during the seven years it takes before a coco-nut plantation comes into bearing; but with a planter on his own estate, cultivating other products for the sake of their annual income, the amount of capital required to become the possessor of a rich coco-nut plantation is not excessive, and should not exceed £10 or £12 per acre, including every expense except the planter's own labour and interest on capital.

At the present price of coco-nuts—and there seems no immediate prospect of this price being reduced—the net income to be derived from an acre of fully bearing coco-nuts would be £10 per annum, so that a comparatively small plantation of a couple of hundred acres would yield a net income of £2,000.

I see no reason myself why the various Governments affected should not give financial encouragement to the establishment of coco-nut estates by helping the planter over the period which elapses before the plantation comes into bearing. If this were done it would open up tropical possessions in a way that we can scarcely realize. It would increase the ties with the European countries, and find good wholesome food for their teeming millions. It would increase the purchasing power of tropical countries, and would open up profitable opportunities of employment for young men who wish to go there.

I may call attention here to the enormous impetus that has been given to the development of Canada by the very simple help the railway companies and landowners have given to emigrants in the way of starting them with a homestead into which to move on arrival on the prairies. This simply means that by making it possible for families to move into Canada, that country has become prosperous and successful. The money for these homesteads is paid back by the emigrants, and I believe that no loss has resulted under this system. If planters were similarly encouraged in the Tropics by the help of a little capital and a bungalow, the security being on the plantation, a rate of interest could be arranged sufficient to cover all risks of loss, and to give the Government granting the loan a high return. It is not possible for any private individual to work on these lines, but it is possible for Governments. There are millions of acres of waste land in tropical countries waiting to be developed, and all that is wanted is a little help from the authorities to convert waste tropical possessions into veritable gold mines, producing wealth beyond the dreams of avarice, in occupation as well as in money, and, in addition, providing food for all.

As a proof of this, let us consider what Government railways have done in developing Nigeria. Surely, with this striking object-lesson in front of them, Governments could

assist in some other way to further develop coco-nut planting and allied tropical industries, so as to ensure that we make the most of this enormous field for human activity. Coco-nut planting is especially suitable for Government experiment in this direction. The profits are so great that any young planter could pay a sufficiently high rate of interest on the capital to allow a wide margin for insurance purposes to the Government, and the security is of the best.

May 21, 1912.

PREFACE.

WHATEVER difference of opinion may exist in London to-day as to the future of the £80,000,000 that have been actually subscribed up to now for planting rubber in the East and elsewhere, and whether, when the top price of rubber drops to 3s. per lb., or lower, Brazilian and indigenous rubber will be left behind, there seems no difference of opinion as to our being on the eve of an active coco-nut boom.

This was particularly noticeable at the London Rubber Exhibition (1911). Interested and absorbed as visitors were in the exhibits, time and again conversations about rubber prospects and possibilities would stop short, and be switched right on to coco-nuts. The idea one gathers from this sudden change is that since the public will swallow no more rubber promotions and still have plenty of money to invest, a new and profitable outlet must be found for them. Coco-nuts certainly offer a very favourable opportunity since there is an insatiable demand for the oil, and, given favourable circumstances, the prices obtainable either for copra or oil, even if the area is considerably increased, will (especially if the matter of by-products and subsidiary industries is carefully studied and followed up) leave a substantial margin of

profit, since the cost of lands suitable for coco-nut planting is comparatively low; that is to say, the prime cost, apart from promoters and boom profits, should be low, and, on the conservative basis of forty-eight trees to the acre and forty nuts to the tree, 2,000,000 nuts, in round figures, can be looked for from each 1,000 acres cultivated.

Meanwhile it is pleasant to see a portion of the surplus wealth of this country being profitably invested overseas, as by such means the basis of our investments is widened and the possibilities of the trade and prosperity of the Empire extended and increased by the addition of other outlets for capital to tea, rubber, sugar, &c. Now it is to be coco-nuts; next, perhaps, soya beans, ground nuts, &c.; last, but not least, when the public want a "sure thing" without 300 per cent. dividend, we shall have cacao. Whatever the industry is, the public will respond provided they see a possible profit and do not have to wait too long for dividends. It will be noticed in the following pages that special attention has been paid to the development of side lines for the purpose of paying a small dividend until the coco-nut palms come into bearing.

Investing their money in these agricultural undertakings forces the public here to be aware that the Tropics are not only jungles or malaria swamps, and stimulates and expands the demand for our machinery and manufactured

goods, thus helping to give more work for the cheaper class of labour on this side, and to improve the lot of the skilled artizan and render his prospects more assured. There is only one uncertainty about the whole matter, an uncertainty, too, that should not exist, and it is this:—

Who is going to plant up and attend to the estates when the promoters, or promoting directors, have left the ship, which they are certain to do sooner or later, be it rubber, coco-nuts, or anything else? Where are all the managers and overseers necessary to immediately supervise the native labourers coming from? Our farmers and agricultural schools or colleges cannot supply them; there is only one thing to do—we must not delay in taking steps to train them; that is to say, we must establish at least two agricultural colleges in the Tropics—say one in Ceylon or elsewhere in the East, and one in Trinidad or at some other centre in the West.

Even if we cannot get our tropical agricultural colleges yet awhile, arrangements can surely be made for those over here, or in our Colonies, wishing to take up tropical planting as a career to join a good agricultural college, and attend special classes in tropical agriculture held in London, Liverpool and other large centres, and then be trained for a year or more at one or other of the leading experimental and botanic stations to be found at all

our chief producing centres. We are glad to see, therefore, that the idea of an agricultural college being urgently needed is rapidly gaining ground. Just before this book was published, a prominent leader writer on agricultural subjects in the principal London papers, who had read the articles in *Tropical Life* and elsewhere, discussed the matter with us; whilst the question was brought prominently before the Tropical Agricultural Conference, held in Trinidad, W.I., in January (1911), when Mr. Samuel Simpson (now Director of Agriculture in Uganda), among others, pleaded that steps be taken without delay to establish such a college.

The Financier, always to the fore in such matters, devoted two columns to the subject in their issue of July 26, 1911. In this they called attention to an article published in *Tropical Life* for January, 1911, when that paper, following up Professor Wyndham Dunstan's idea, suggested that a college be founded in Ceylon as a memorial to King Edward VII. After this *The Financier* dwelt fully and appreciatively on Professor Wyndham Dunstan's introductory remarks on the subject in the book issued by the publishing department of *Tropical Life*, entitled "Notes on Soil and Plant Sanitation on Cacao and Rubber Estates," when they said:—

"The evolution of the idea of an agricultural college for the training of young tropical

planters has been outlined by Professor Wyndham Dunstan, of the Imperial Institute. In the course of an interesting introduction to Mr. Hamel Smith's recently published 'Notes on Soil and Plant Sanitation on Cacao and Rubber Estates,' Professor Dunstan considers 'it is high time that we recognized, as France and Germany have already done, that it is not safe to depend upon the chance acquisition of knowledge during the kind of apprenticeship into which young men now usually enter as a first step in the planter's life.' In his opinion the young planter can find opportunities in this country for his preliminary scientific studies, either at the Agricultural Departments of one of our Universities or at one or other of the agricultural colleges, where many of our most successful farmers at home and in the Colonies acquired the rudiments of that knowledge which has stood them in excellent stead in after life.

"Professor Dunstan recognizes what the most ardent advocate for an agricultural college would be the first to admit—namely, that such an institution has its limitations. The practical details connected with successful estate management in the Tropics can be learned only on the estate, but the youngster setting out to acquire this knowledge would find himself face to face with problems which cannot be solved by anyone lacking adequate scientific acquirements. The question naturally arises as to

whether it would be possible to carry the beginner's training far enough under the conditions which obtain at home to enable him to complete his knowledge in a thoroughly satisfactory fashion when working on an estate. This would be, in ninety-nine cases out of every hundred, impossible as things are at present, and that for reasons which must be obvious. It is at this juncture, then, that a properly placed and an adequately equipped agricultural college in the Tropics would prove of real service to the learner. What, then, is wanted is the taking of immediate steps to see that this idea of an agricultural college in the Tropics—let us say, for argument's sake, in Ceylon—is brought to fruition. In common phrase, it is up to them (the leading men in the tropical planting world) to make a move, and, in our opinion, the sooner they do so the better."

With these remarks we cordially agree. In ten years' time the romance, but not the possibilities of assured incomes, will be knocked out of tropical planting; and then, if boys at school and men at college are not trained from the start to look to the Tropics as they now do to the Church, Army, Navy, or the Bar as a profitable method of earning a living, and if they are not coached-up to follow such a career, we can never expect to hold our own against other nations in tropical development and agriculture.

To help call attention to the advantages and profits to be derived from the "The Cult of the Coco-nut," we have spared no pains in placing before the reader in this book, so far as the space of a portable hand-book will allow, the complete subject of the coco-nut palm, its cultivation, and the products to be obtained therefrom, in as lucid and concise a manner as possible, and have aimed at making each section of it as self-contained an epitome as feasible, so that without having to wade through pages and pages of matter already familiar and acquired, each reader may hit readily upon such information as is of special interest to him. This volume, in a word, has been arranged so as to mainly deal in plain language with the practical side of the Coco-nut industry and to emphasize, in the first place, all information which should lead to an interest being taken in, and to the adoption of, an Industry which has played, and is destined to play in the near future, an important part in the successful development of some of our most promising Tropical Dependencies and Colonies. The short ramble into the realm of the history of the palm where we wander at times will not prove, we trust, wearisome and beyond the patience of the reader. The article dealing with "Health in the Tropics" will be found a homely but practical addition for the vast body of readers, to whom the Tropics are as yet a sealed book. The general

line of conduct pointed out in that article will, we hope, be received with approval by those who have a long sojourn in the Tropics to their record and can therefore assure others that the enjoyment of good health in unaccustomed places is not so difficult to attain as some folks make out, but is a boon well worth striving for. Most of the regions in the Torrid Zone, where the White Man's calling now compels him in increasing numbers to spend his days, require especial care for the conservation of his health. On this account the advice of "an old hand," perhaps, will not be amiss, and will, we hope, lead to the lasting benefit of many of our readers. Therefore, without dwelling too much on either the *pros* or *cons* of a tropical planter's existence, the authors have been at special pains to point out the vicissitudes and trials of a coco-nut planter's life in an unbiased and unvarnished manner. Through it all, however, we trust that we have succeeded in conveying the patent fact that although this industry calls for much patience and resource in the establishing and building up of an estate and of pecuniary sacrifices at the outset, yet the result, perhaps with a few unfortunate exceptions only, and these nearly always avoidable, will be ultimate fortune, a fine livelihood, and a sound reliable investment and property, annually growing in value, which in its stability is excelled by none, and equalled by few.

Readers will notice that, the same as with our "Notes on Soil and Plant Sanitation," we have sacrificed appearances for utility. Long experience in the use of handbooks, both here and abroad, has caused us to prefer a compact volume, in plain close-set type, to a more showy book, perhaps three times the size and yet containing no more information. Believing that our readers will share this opinion, we have put up the book as seen, condensing the large quantity of information it contains in the smallest possible space compatible with legible printing and easy reading.

Acknowledgments are gratefully made to Mr. Stuart R. Cope, for kind assistance in the revision of the proofs of this book, and to the Cie. du Boror, the Klanang Rubber Co., the *Philippine Journal of Science*, The West Indian Departments of Agriculture, Messrs. Dean Worcester, Johnston and others, for permission to reproduce various illustrations, which have greatly added to the interest of the volume, and which, we trust, will attract attention to their own publications, which specialize on the various subjects.

London, H. H. S.
January, 1914.

INTRODUCTION.

HEALTH IN THE TROPICS.[1]

I ALLOW myself a fair judgment under this head, because I have lived and worked for over twenty-five years almost continuously in some of the worst reputed sections of the Tropics, and in the Torrid Zone more especially, yet have come through perfectly unscathed, still possessing to-day a clear, sound mind and a body unimpaired and capable of undertaking, without damage, still further sieges of the same conditions. Experience is, after all, the best guide in this instance. It is true that I started young to sojourn in those regions, with a physique as "sound as a bell," a lot of common sense, and no fear or apprehension of what might happen to me in the prosecution of the calling which I was at the time engaged in. I even indulged upon occasion in actual manual labour, such as seafaring in the northern waters of Australia and in the Dutch Islands, pearl-fishing in the Torres Straits and New Guinea, and so forth. I have listened to the opinions of many medical men in my

[1] Contributed by F. A. G. Pape.

time and they were all agreed that experience was the greatest asset and most to be trusted. I have even heard medicos listen patiently and deferentially to the diagnosis of an "old hand" upon his own case, when called to the bedside of such a smitten one, and adopt as a rule a line and course of treatment in conformity with the advice of the sufferer. I have come to the conclusion that each human body is differently constituted to another and therefore suffers differently and assimilates medicaments and even foods differently. While one man thinks nothing of taking quinine by the spoonful, another man's system will endure the most violent discomfort from fractional doses of what the former takes with impunity.

We must first of all always remember the indisputable fact that the dweller from a temperate or a rough clime is primarily not destined or suited for long-continued habitation in the opposite extreme—viz., in the Torrid Zone—without some sort of damage to his constitution. He is forced to adapt himself to his novel and unaccustomed surroundings and to quite a different mode of life. All and sundry, therefore, who contemplate going to the Tropics to earn a living should submit to a thorough medical examination before doing so in order to reassure themselves at the beginning whether they are really fit for the change and robust enough to bear it. This examination, also should preferably be made

by a medical man who has had experience in the Tropics, because such a person can approach the subject with much more confidence and success than a man who has only hearsay knowledge. For those who are inclined to ridicule this idea of a good examination before setting out, I will mention that it has unfortunately been my lot to witness many hundreds of sad cases where the change proved fatal within a very short while. Young and most promising lives were cut off in their prime just because they were not suitable. The last resting-places of all our Colonies are full, to everlasting sadness of the graves of such people. I will, of course, not assert that the initial pronouncement of fitness conveys an infallible guarantee of immunity—far from it; it is only the prime and essential requirement.

With regard to hints on general conduct in the Torrid Zone, I would say that the conduct of the individual and his personal behaviour have a very great deal to do with his welfare and well-being. So many thousand rules have been laid down for the conduct of the "new chum" that it is hard indeed to separate the chaff from the grain. The demand for young blood in this and kindred tropical industries has become so large, and the attractions themselves for the work are so great, that the majority, in their eagerness to get there, are apt to neglect the most important

precautions, and listen to the specious blandishments of the Tropical outfitter and his kind, who care not a jot, so long as they can load up the unwary with a long list of the most useless paraphernalia of the truly gaudy kind, which a sane person can well imagine but fights shy of. Of course the demand has created quite a number of emporiums where everything one buys is good and useful at an equitable price, but the tendency is still to turn out stuff which only a pampered multi-millionaire would find any use for. My advice is to select as few items of gear as possible at home, with just enough tropical kit to carry one through the sea trip to your destination. Out on the spot there is ample provision for all the proper and actual requirements the heart desires. It is often a sight fit for the gods to witness the arrival of a self-conscious "kid" fresh from home. The fellow-passengers on the way out have probably been treated *ad nauseam* to his peacock glory; his will be the finest of leather trunks (for the rain and mould to spoil and the white ants to have a feast upon); his the shiniest of tan shoes, the gaudiest of "puttees" or leggings (for riding fence-rails, as only in exceptional cases probably will he be able to straddle a pony); his the latest cut of riding-breeches and fancy coats with dozens of pockets contrived all over them in the most startling manner; his the cummerbund of rainbow hue and fancy socks

which a gander would instantly fly at. The hue of his ties will put in the shade the plumage of butterfly and humming-bird, and his collars will make fine "cravats" for nailing upon a coco-nut tree to prevent rats from climbing up it, they are so wide. All this is folly and waste of good money. Go fit yourself out well by all means, but let it be with materials suitable for your calling. A good steel trunk will do infinitely more and better service than a leather one; stout, well-made shooting boots are absolutely necessary, although there may be occasions when our young buck shall disport himself at the local gymkhana or on the Club lawn in decent tan or tennis shoes, with a neat flannel suit and loose silk shirt with tie, or even the full glory of a "boiled" shirt and hard collar.

The principal aim of the tropical planter is so to clothe himself that he will suffer and be incommoded in the least degree by the ardent rays of the sun and the immoderate showers of rain and storms. He who is least inclined to adipose tissue will always have the advantage. In the first place he does not perspire like his more unfortunate brother of the ample habit of body, and he will not have to stand the same risks of ailment from the principal organs, such as the liver, the kidneys, and the heart, which the constitution of the stout man generally predisposes him to.

Wool garments are to be worn next the

skin in preference to any other material, for wool deals with the moisture and perspiration in a much more efficient manner than cotton does; for instance, wool, when it is wet, keeps the body much better ventilated and warmer than cotton. A wet cotton undershirt feels like ice and in most cases brings on a chill, which in its turn leads to fever. It is not necessary to have the woollen undergarments of uncomfortable thickness, for there are many very fine and light grades to be had. Woollen socks also should, in my opinion, always be worn, but very frequently changed and washed afresh. A good plan is to change all your undergarments, including your socks, at least once a day, leaving what you take off to air for the next spell of wearing. As regards outer garments we have long since got away from the idea that light flimsy weight and colour are the best protection. There are loosely woven yet strong woollen fabrics on the market nowadays which are far more fit and suitable for the tropical planter than the cotton twills and canvas goods which one swore by a decade or so ago; for it must be remembered that one does not want to be too thinly clad, or the sun will burn through your clothes to an uncomfortable degree. Of all these I consider that the one-time famous "khaki" is the worst; it is heavy, stiff, and feels like a sheet of tar-paper when wet. No ventilation worth the name is possible on

account of its close weave, and therefore it keeps the wearer hot and perspiring. The comfort is *nil*. The only dubious advantage it did possess was that it imbued the wearer with a kind of pseudo-authority in the eyes of the natives, owing to its being also the material used for the clothing of the King's forces. Do not, therefore, wear khaki if you can help it. The material is good enough for a pair of breeches, because its strength makes it almost impervious to thorns and untearable; also the "dhoby," or native washerman, cannot readily destroy it as he does your other things, by his favourite method of beating it upon stones in his washing process. Khaki, in contradistinction to other fabrics, does not mind mauling, and will triumphantly outlast even the dhoby and all his wiles.

Too much care cannot be bestowed upon the adequate protection of your head and the top of the spine from the sun's rays, especially in the middle of the day. Planters, of all people, must be out in the middle of the day on innumerable occasions. Most other callings allow of the spending of the hottest hours inside the house, or at least in the shade; a planter cannot count at any time on such privileges. There are all sorts of things to be attended to which require his presence out in the glare. Now we all know that the native is used to going about bareheaded at all hours, but the European can by no means

stand this even for a short while. He must have first-class and perfectly safe head-covering. There is for this purpose nothing to compare with the helmet made out of pith, and the best shape is that which comes well down over the temples and covers the neck in such a manner that even in stooping it does not expose the wearer. The best shapes are the mushroom and the "Cawnpore Club," as worn by me in East Africa (see p. 144). The worst drawback to a pith helmet is that in the rain it becomes soggy and extremely heavy. It will take up quite a lot of water. On this account, when raining, very thin oil-silk covers are useful to cover the helmet for those who dislike carrying an umbrella. The best thing to keep off the everlasting rain in the monsoons is a large-sized Chinese umbrella, which costs about eightpence. Mackintoshes are a nuisance. Some people adopt the enormously wide hats, plaited of reeds, made by the Sundanese people in Java. These are often three or more feet in diameter, closely woven, and the outer surface covered with a gum or resin which makes them perfectly impervious to the heaviest shower. These hats are held to the head by means of a rim of bamboo fitting the circumference of the head and this rim is fitted to the underside of the hat by means of little wooden stilts, which ensures plenty of ventilation. Other people again favour the "rain capes" made of coir fibre. It is evident from all this

that the natives are far cleverer than ourselves in protecting themselves from the elements. Rain is the most disagreeable state experienced by them, and so they have set their wits to work to guard themselves effectively against it. I have shown that it is important to guard oneself from the direct action of the sun no less than from the rain. Undue exposure to either will surely bring on fever, the bane of existence in the Tropics; no man hardly ever escapes some bouts of it at one time or the other. Ill-effects of the sun should be most promptly treated with cold bandages to the head, and, where procurable, with ice; sedatives are also essential and the patient should be kept in a cool dark room. Noise is harmful; a parrot or a chattering monkey in the veranda should be removed to the coolie lines, or, best of all, shot. They are both an abomination and better left in their native jungle where they belong.

When one has tramped around in the cold, damp and rain, and has perspired to boot, it is well to have a good hot "grog" brewed, and partake of a light dose of quinine mixed with it. Now, I do not mean to counsel a constant recourse to the bottle on the occasion of every shower, for moderation is the best course in all things; but it cannot be gainsaid that a little alcoholic stimulant is beneficial in such emergencies, and of all the stimulants in the Tropics, the fine, unadulterated "Hollands Geneva"

is the best. Geneva acts directly and beneficially on the kidneys, which are apt to get out of gear in the Tropics, and a little stimulating aid is not at all out of place now and again; and, of a truth, I am not alone in my advocacy of this. Go for proof of my statement to the Island of Java, which has been under the sway of the Dutch for several centuries. You will find there plenty of people, sturdy and hale at three score years of age and more; they have all used moderate alcoholic stimulant all their lives. Good, unadulterated claret for table use is also excellent, but avoid beer. There is one other thing which the Dutch have done and that is a shaping of their daily lives much upon the fashion of the natives; they rise early and go to bed early. They do most of their work in the coolest portion of the day; they bathe often, but always take the chill off the water; they do not eat heavily of meat, preferring poultry and fresh fish with plenty of vegetables and always wholesome ripe fruit.

Therefore, aim at foodstuffs easily digested; remember that your inner apparatus is working under high pressure in the Tropics and you must not put too much of a strain upon it. All violent games, such as football and hockey, are to be deprecated, though tennis in moderation is not harmful. Horseback exercise is capital for those able and fortunate enough to be able to indulge in it, but every

where we are confronted with the necessity of moderation. While on this theme of sports, it is useful to bear in mind that it hurts in the long run to discard your hat or cap while playing games when the sun is well above the horizon and can still sting. Meals should not be partaken of in "starch" and "stiff tucker," as is only too universally the tendency in the East. The planter, to whom this volume is mainly devoted, is happily in a position to indulge himself on most occasions the year around, in the matter of loose and easy raiment in his own bungalow, when feeding his inner man. Let the man in the cities and trade centres stick to his "boiled" shirt and collar; he has probably an opportunity at frequent intervals to take recuperative trips home. But he will always be eager and willing, for all that, to receive an invitation to your wide and intense life, O Planterman! to don a flannel shirt and spread his loosely clad legs under your ample and hospitable board, spread probably with healthier fare than the more pretentious tables in town.

Epidemics of sickness are still of somewhat frequent occurrence, and among the most to be dreaded are cholera, plague and small-pox. Fortunately, modern medical science has been able to take the worst features from these scourges, by sanitary measures and by inventing and applying serums which, if inoculated promptly, considerably lessen the death-rate.

Modern disinfectants also, when reliable makes are used, go a long way to help. Fortunately, the members of the Caucasian race are to a great extent immune from the dread visitations. This is in a great measure due, no doubt, to personal cleanliness and the sanitary mode of life practised by them. The danger of infection is lessened in their case by strictly clean surroundings and habits; and the germs can only be indirectly conveyed by the servitors, or by personal contact with the natives. The highest point of danger is always at the change of the seasons, which are mostly accompanied by extraordinary weather conditions, either of heat or damp and cold.

The best preventive is to preserve a calm, unruffled mind; one must never give way to fear or morbid moods; be a little extra careful at this season what you eat and what you drink, but do not ever give in to funk; that is the worst thing one can do, for it has been conclusively proven that people have been attacked and have succumbed through sheer funk. The very stamina of body and mind of a European is his best safeguard. Nervous and weak individuals are, therefore, better in some other localities at such a time of stress. The oft-repeated precept of boiling all water before using it for drinking purposes is a wise precaution. However, since the boiling takes out most of the essential properties it will be

found useful to keep in stock one or other of the foreign bottled table waters, which are nowadays readily obtainable everywhere at a reasonable price. These waters, as a rule, contain slightly aperient properties, and are for that reason strongly to be recommended. One of the most important cares in the Tropics is that of the bowels. Functionary disarrangements in this direction are highly dangerous and need instant attention, for regular habits, remember, minimize risks more than any other precaution. The bowels are apt to get a chill more readily than any other part of the body, and for this reason it is most judicious to wear a woollen stomach belt constantly. The majority of Eastern people recognize this and it finds expression in various fashions. The Indians wear the cummerbund, the Turks and Persians a very voluminous sash, and other nations similar garments, chiefly for the protection of the bowels.

A house where one wishes to live healthily and with comfort should have good drainage. The lavatories, bathrooms, kitchen and servants' quarters should be at some distance away from it, and at a lower level preferably than the bungalow itself, in order to obviate definitely all unclean fluids coming in contact with it.

Never build a dwelling-house directly on the ground without some ventilation being provided underneath it. In the Tropics

everything must have air and sunshine, or it will become dead, unwholesome, and dangerous. I do not consider the bungalow style of building the best or most advantageous at all, and a bungalow without ground ventilation or one with a low roof is always damp and unhealthy. The rooms smell musty and damp, especially in the rainy season, and the inhabitants will almost invariably be found to suffer from rheumatics, colds or ague. In a locality where stone and lime abound it will be found expedient to put up walls, for the ground floor at any rate, on a good sized plinth, but where good attention has been paid to the construction of a wide roof, even the walls are not necessary, and galvanized iron, match-boarding or bamboo matting may be used, all according to the length of purse or inclination of the man who is going to live in it. The last named, bamboo matting, is made by the natives very cheaply indeed. They use the bamboo sliced into strips, which are woven into large squares with handsome patterns even. This matting is made to fit the walls or divisions of the house with the window spaces left out. The edges are bound with bigger bamboo battens or with wooden laths. This method is quite pleasing and has the advantage of not costing much. From a sanitary standpoint, however, it has its drawbacks, because all dust and dirt, as well as insects, are attracted and

easily settle upon it, even if one frequently applies a thick coating of whitewash. A lot of borer insects attack it also, so that it will not last more than half a dozen years, when it has to be renewed at considerable personal discomfort to the dwellers in the house.

Mosquitoes are also apt to favour such a house if it is not frequently cleaned and whitewashed, and all doors and windows should have screens for keeping out mosquitoes, flies, and other noxious insects. In many localities, especially where the house is not built well above the ground level, one must also expect such unwelcome visitors as snakes, lizards, centipedes, scorpions, and other denizens of the jungle. I am not of a nervous disposition, but, like a good many people, I object to a houseful of such weird guests. They will surely put in an appearance if they are not kept out by the aforementioned means. Mosquitoes are the "bane par excellence" of the Tropics. On most coco-nut-growing ground they are not the recognized fever-carrying species, but then one never knows what any mosquito may not carry and convey in the process of helping itself to your blood, which operation alone, moreover, is heartily resented by all and sundry. Better keep them all out. Fine-mesh wire netting does not cost much, and any native carpenter is able to make well-fitting frames for your windows and doors. All beds and sleeping-places

ought to have good secure netting as well, and remember that twice the size of the bed you are used to at home is not too much if you value plenty of fresh air and freedom of movement at night in the Tropics.

Having been in New Guinea, I can confirm the following list as being an excellent one for those setting up a stock of drugs for their estate use. I take it from Mr. Staniforth Smith's excellent handbook on Papua, or British New Guinea, feeling certain that what suits so distant a part of the Tropics can well be adopted elsewhere.

List of drugs, &c., which should be kept at out-stations, &c. :—

Thermometer.	Syringe.
Lint.	Quinine (5 gr. Tablets).
Cotton Wool.	„ (2 gr. „).
Bandages.	„ Mixture.
Jaconet.	Tincture of Opium Tablets.
Carbolic Acid.	Sweet Spirit of Nitre.
Boric Acid.	Chlorate of Potash Tablets.
Tablets of Zinc Sulphate.	Cascara Tablets (2 gr.).
Tablets of Lead Acetate.	Sulphonal „ (5 gr.).
Carbolic Ointment.	Livingstone Rousers.
Boracic Ointment.	Calomel (5 gr.).
Sulphur Ointment.	Epsom Salts.
Paregoric.	Tonic Tablets.
Pair of Scissors.	Turpentine Liniment.
Chlorodyne.	Iodine Liniment.
Bluestone.	Potassium Permanganate.
Phenacetin Tablets.	Adhesive Rubber Plaster.

In the same handbook we are told that under the "Native Labour Ordinance of

1906" employers of more than ten natives are required to keep at the least the following drugs, &c., on hand, for use as occasion may require:—

Epsom Salts.	Sulphur Ointment.
Castor Oil.	Bluestone.
Lint.	Laudanum.
Bandages.	Quinine.
Lysol or Carbolic Acid.	Permanganate of Potash.
Boric or Zinc Ointment.	

Whilst, for more than thirty natives, you must stock in addition to above:—

Thermometer.	Easton's Syrup.
Surgical Knife.	Crude Carbolic Acid for Disinfection.
Chlorate of Potash "Tabloids."	Adhesive Plaster.
Tinct. Camphor Compound (Paregoric).	Book of Instructions.

During recent years, however, especially since the above was printed, considerable improvements and inventions have been reported in the drugs themselves as well as in the methods of their preparation and of putting them up. This has especially been the case with drugs intended for use in the Tropics, where ability to keep is all important, and compactness a virtue to be desired. The quality of quinine is particularly important. Properly used, quinine spells freedom from fever, but the native article is mostly bad. *Good* quinine is as essential for personal comfort in the Tropics as a pair of boots, in

fact far more so. One cannot entirely avoid being bitten by mosquitoes, but as quinine is "fatal" to the fever germs transmitted by the insect, it is a wise precaution to take a dose every day before the first meal, as a preventive medicine. This is the plan practised by Sir Ronald Ross, of the Liverpool School of Tropical Medicine, and those following his example will find Messrs. Burroughs Wellcome and Co.'s "Tabloid" Quinine to be the highest quality available, and so compact that a large supply can easily be carried in the vest pocket. These "Tabloid" medicines are pure, keep well in all climates and prevent waste. For those who prefer quinine in powder, or who dispense it in quantity for use on estates, &c., the same firm's "Welcome" brand quinine is of the greatest value. This may be had either in large flakes, or, better still for convenience, I should recommend the same quality in compact crystals, which occupy one-third of the space, are less costly for transport, and easier to store and handle. Another excellent idea is "Vana" Tonic Wine, particularly useful to those who suffer after-effects from taking quinine in the ordinary way. "Vana" is a splendid thing for convalescents in particular.

By far the simplest and readiest way of solving the difficulty of selecting and packing all these requisites is to get a properly-fitted medicine chest. Some of these are so portable that they can be carried in the coat

pocket, and Messrs. Burroughs Wellcome and Co., who have supplied practically everyone of note, literally from "Pole to Pole," including Peary and Amundsen, with medical outfits, are to-day the greatest experts in everything pertaining to medicine chests and cases. Owing to their long connection with expeditions into Africa and other tropical centres, this firm has greatly increased its experience, which it is at all times willing to place at the disposal of those going abroad. For general use their "Tabloid" Case, No. 231, suggested by Sir W. Moore, is one of the handiest. This is fitted with "Tabloid" products, &c., as recommended in Sir W. Moore's "Manual of Family Medicine in India," and weighs, complete with drugs, dressings, and minor surgical instruments, &c., rather less than 7 lb. A most excellent little case is "Tabloid," No. 233, strong and simple in construction, and yet adapted to wide variations in the quantities carried of various drugs. This is a good case to have fitted to one's own requirements.

Suggested list of contents for a No. 231 "Tabloid" Brand Medicine Case :—

"Tabloid" Quinine Bisulphate (gr. 3).
,, Aromatic Chalk Powder with Opium.
,, *Phenacetin Compound.*
,, Laxative Vegetable (s/c).
,, Bismuth and Soda.
,, Iron and Quinine Citrate (gr. 3, s/c).
,, "Gingament."
,, Ammoniated Quinine.

"Tabloid" Potassium Chlorate (gr. 5).
,, Warburg's Tincture (min. 30).
,, Ammonium Bromide (gr. 5).
,, Ipecacuanha (gr. 5, sine emetine).
,, Salol (gr. 5).
,, Gentian and Soda Compound.
"Soloid" Boric Acid (gr. 6).
,, Potassium Permanganate (gr. 5).

Whilst the following sundries could be added with advantage:—

Dredger of Iodoform.
Court Plaster.
Tooth Stopping.
Mustard Leaves.
Tube of "Hazeline" Cream.
,, "Borofax."
2½ in. Bandages (Compressed).
1 in. ,, ,,
Compressed Lint.
,, Triangular Bandages.
,, Absorbent Wool.
Spool of Adhesive Plaster.
Lancet.
Pair of Scissors.
,, Dissecting Forceps.
Clinical Thermometer.
Suture Needles (assorted).
Reel of Suture Silk.
Caustic Holder and Point.
Silk Web Catheter.
Tube of Safety Pins.
"Tabloid" Cubes Magnesium Sulphate.

Suggested list of contents for a No. 233 "Tabloid" Brand Medicine Case:—

"Tabloid" Quinine Bisulphate (gr. 3).
,, Rhubarb (gr. 3).
,, Phenacetin Compound.

"Tabloid" Quinine Bisulphate (gr. 2).
,, Ipecacuanha (gr. 5, sine emetine).
,, Iron and Quinine Citrate (gr. 3, *sugar-coated*).
,, Potassium Chlorate (gr. 5).
,, Bismuth and Soda.
,, Laxative Vegetable.
,, Soda Mint.
,, Cascara Sagrada (gr. 2).
,, Sodium Bicarbonate (gr. 5).
• ,, Tannin (gr. 2½).
,, Calomel (gr. 1).
,, Potassium Permanganate (gr. 2).
,, Podophyllin (gr. ¼).
,, Tinct. Capsicum (min. 1).
"Soloid" Boric Acid (gr. 6).
,, Zinc Sulphate (gr. 1).

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ERRATA.

P. 71, line 2, *for* "p. 416" *read* "p. 528."
P. 176, line 31, *for* "aro" *read* "are."
P. 295, foot-note, lines 4, 5, *for* "pp. 406, 407" *read* "526, 527, 529."
P. 297, in table, Oil in Sun-dried Seashore Nuts, *for* "27·7" *read* "7·7," as on p. 527.
P. 331, line 19, *for* "January, 1913" *read* "January, 1912."
P. 425, foot-note, line 4, *for* "£10" *read* "£5."
P. 461, foot-note, *for* "p. 175" *read* "p. 75."
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COCO-NUTS—THE CONSOLS OF THE EAST.

THE COST OF A COCO-NUT ESTATE.

We approach this subject with a good deal of misgiving, for in order to give a correct estimate it would be necessary to quote different figures for nearly every locality, some of which vary so much, as can be seen with those given, that great caution is necessary in giving advice to others. Whilst, we are told, it is possible to purchase an acre of planting land in the South Sea Islands, and elsewhere, for a few shillings, the price of good land for such purposes may reach £5 to £6 per acre in Ceylon, and even more.

The same divergence exists in the cost of labour, which in the Pacific Islands, in East Africa, and Madagascar does not exceed 6d. per head a day, whilst in Ceylon, the Straits, and the West Indies it is never less than 1s. per day and frequently more. Although it is by no means a general rule that the drawbacks of one part compensate those of another, it can be set down as fairly certain that where

the higher prices for land and labour prevail there are also counteracting advantages to be met with to improve the chances for the most lucrative establishment of coco-nut plantations, otherwise the centres in dispute would be ignored entirely as unprofitable.

For these reasons we have, where possible, kept the various centres apart and included in each estimate the cost of land, clearing, labour, &c., but, as can be seen, we have not always done so. The index, however, shows at a glance what estimates are included in the book, and where each one is to be found.

We have heard it stated by quite responsible authorities that the more confined the area of a coco-nut estate, the greater are its chances of ultimate success, owing to the possibility of more intensive cultivation and closer personal supervision. This theory will not hold with coco-nuts, which cannot be pruned back or trained to take up less room ; like a huge bird, they must have room to flap about in, and move their leaves freely to the wind. Again, system and method will successfully serve on a large estate as on a small one, and, be it large or small, if the best work is not to be put in, it would be better not to start planting at all.

If a big estate has an adequate labour supply and is divided into suitable sections, so that the size of each is one which a superintendent can well and conscientiously handle without worry

or overwork, and if the superintendents work together with the manager in perfect harmony and good understanding, there is no reason to limit the undertaking in any way. On the contrary, we have endeavoured to show that it is the largest estates, with help of cattle and other subsidiary industries, which pay the best.

For these reasons, it is naturally imperative that the manager and head of all should be an exceptionally able administrator and planter with the maxim that knowledge, penetration and tact, justice, fairness, firmness and strictness are essential qualities.

Coloured labourers are not the numskulls and dunces one is apt to take them for, and with them the character and reputation of a wise and just manager carry weight and are recognized by those under his charge, not only on his own plantation but elsewhere, for his reputation goes far afield, and at the call of one who is popular there is never any dearth of recruits coming forward for work; in other words, there is far less risk of scarcity of labour on estates which possess a successful and popular manager, who knows how to handle the men firmly and tactfully, and unless such a chief is available, satisfactory progress will never be made.

The staff under him is of far less importance, for a keen and up-to-date manager will speedily detect and weed out the chaff from the good and conscientious workers, whilst a good "sub.,"

harassed by an indifferent manager, will soon lose patience and leave to go to perhaps a friendly, but none the less a rival, estate without any sentimental considerations.

Nothing but the extreme welfare of the estate entrusted to him should have the slightest influence on any of the manager's actions. The man to be selected should not only know personally every individual under him, his likes and prejudices, how he fares and how he conducts himself, even to the cares and little worries of his family, but he should have in his mind, like the doctor in the hospital, a note of each tree and its progress, as well as a shrewd idea of what produce, stores, and implements are on the estate, and how it goes with the animals and live stock generally.

For these reasons, those who want a responsible and able manager must see to it that he is not unduly pestered with petty and nerve-racking worries of lesser importance that can well be attended to by his assistants, such small things being outside his province; avoid also too frequent official reports and investigations which are irrelevant to the matter in hand, but which may be demanded by a nervous Board of Directors not well up to the work personally, and therefore at the mercy of some over-zealous shareholder or scientific faddist at home.

As far, therefore, as the housing of the manager and staff goes, it is unwise to stint in this respect and to provide an unhealthy or

uncomfortable dwelling among dingy surroundings for your chief men. Remember that a little taste and artistic adornment in the Tropics need not cost a great deal, whilst they can and do go a long way to "buck up" and sustain a man after a hard day's work, or during times of stress. Liberality in this connection will be appreciated and will make for contentment, steadier living, harder work, and general readiness for the arduous duties of the staff.

Where the occupation is confined to an island or solitary existence, it even pays to provide means of sport, such as boats, ponies, a billiard table, tennis courts and so forth for the lonely ones. Doing so always pays. Contented minds and freshness for the work after mental and physical recreation are secured by this consideration.

For general purposes, as giving a concise and lucid insight into the figures of outlay demanded for opening up an estate of 500 acres of coco-nuts, we do not think we can do better than agree with the pamphlet compiled on the subject by Mr. L. C. Brown, Inspector of Coco-nut Plantations for the Federated Malay States, who quotes :—

	Dols.
Premium, $3 ($ = 2s. 4d.) per acre; quit rent, $1 per acre; survey fees, $1 per acre. Total	2,500
Clearing the land, $12 per acre; drainage (coast district), $12 per acre; seed nuts, $2,750...	14,750
Fencing, $3 per acre; lining, holing and planting, $2 per acre. Total	2,500

	Dols.
Dwellings, bungalow and coolie lines	1,700
Implements and tools, office equipment, medical stores	1,850
Initial cost of weeding, six months ($1.50 per acre per month)	4,500
Management and provision	3,600
Contingency provision	1,000
Total expenditure for the first year ...	32,400

In the second year we have the biggest item of weeding, placed at $6,000; superintendence, $3,600; land rent, $500; renewals of implements, medicines, contingencies, &c., $2,000. Total	12,100
In the third year there is the same amount allowed, viz.	12,100
In the fourth year the weeding is reduced to 60 cs. per acre, which leaves	9,700
In the fifth year still further reduction, say 50 cs. for weeding, leaving	9,100
In the sixth year the rent advances to $2 per acre, or $1,000; weeding, $3,000, superintendence, $3,600; but there are now small returns and the cost of picking will amount to $300, curing to $1,130, freight, $1,130, or a total of	10,160
In the seventh year the additional charges bring the total to	14,800
In the eighth year to	17,300
In the ninth year the charges for picking, curing and transport have advanced considerably and we have a total of	19,400

After considering the expenditure we turn to the returns, which are as follows: from the sixth year onwards:—

	Dols.
For the sixth year one may safely count on 10 nuts per tree; assuming that only copra is being cured, there will be a yield from these of 1,130 piculs (1 picul = $133\frac{1}{3}$ lb). It takes 220 large nuts to produce 1 picul.[1] The picul is worth $8.00, *ergo* total ...	9,040
Seventh year, from 3,400 piculs of copra at $8.00	27,200
Eighth year from 4,500 piculs of copra at $8.00	36,000
Ninth year from 5,650 piculs of copra at $8.00	45,200

From the tenth year onward the returns increase rapidly, while beyond a repetition of the fixed charges, such as rent and salaries and stores, there is no big item of expense.

It will be seen that by the end of the ninth year, as above, the returns almost catch up with the initial expenses.

It has been a protracted wait, but from the tenth year onward the profit is most substantial and stable, so that barring cyclones or tidal waves, the chances of which calamities are very remote, the investor can be perfectly sure of handsome returns on his original investment.

With regard to the returns given above, it is calculated on an average that 3 nuts go to 1 lb. of copra; still we quote as we find in this case, the figures coming from the following authority:—

"On rich alluvial soil, trees have been known to give fruit in their third and fourth years,

[1] We find this low, but on the other hand the selling value of copra is now much higher.

but on the whole an average of say 10 nuts per tree in the sixth year, 30 nuts per tree in the seventh year, and 50 nuts per tree afterwards is all that can be expected, though with good cultivation the crops are often in excess of this estimate.

"The average price of coco-nuts for the past five years, *i.e.*, from 1905 to 1909, has been a little over $30 per 1,000, and of copra $8.65 per picul. An average return of copra under ordinary circumstances is 4·30 piculs per 1,000 nuts, but this percentage is often greatly exceeded where proper attention is given to its manufacture."[1]

In order to provide a complete contrast as regards the initial cost of a plantation, we will follow above figures for Malaya with those obtained from Micronesia, under recent German auspices. The area of the following enterprise is over twice the size, viz., 500 hectares, say 1,250 acres (1 hectare = 2·471 acres); but the initial divergence is palpably in favour of the latter, where land costs practically nothing worth talking about. The intrinsic value of the land may be slightly inferior on the whole, but it is not so to a radical extent. These quotations are taken from the work of Lieutenant Hans Zapernick, "Die Kultur der Kokos-Palme," Leipzig, 1910.

[1] "Guide to Coco-nut Cultivation in the 'Federated Malay States,'" p. 13, issued by the Malay States Development Agency.

Calculation of cost of a plantation of 500 hectares :—

		Marks
(1)	500 hectares of land, at 5 marks per hectare	2,500
(2)	Survey fees and registration (average) ...	1,000
(3)	Boats for getting about—one sloop, one row boat...	6,000
(4)	Expenses for keeping boats in order (six years)	1,800
(5)	Tools for six years: spades, hoes, machetes, axes, &c.	1,800
(6)	Fifty labourers and their keep for three years	5,000
(7)	Another batch of fifty more labourers ...	5,000
(8)	Wages of the labourers, at 6 marks per month—total	21,600
(9)	Seed-nuts	1,500
(10)	Dwelling-house, store, boat-shed, tool-shed, coolie lines	10,000
(11)	Wages for one assistant—200 marks per month, and free station	14,400
(12)	Emoluments and living for the principal...	18,000
	Total	88,600

All of this amounts in English money to less than £4,500. A most promising prospect indeed. The time when the first crop is to be expected is given at the seventh year, but this cannot amount to much, perhaps a few nuts per tree.

The Germans, as can be seen in the notes on Samoa, New Guinea, &c. (p. 119), have shown the most extraordinary activity and enterprise of late in bringing some of the islands they acquired under systematic cultivation.

They started out from Samoa, where they held interests first of all, and spread to part of Eastern New Guinea, the Carolines, New Hebrides, the Bismarck group, &c. They devoted a good deal of time and money to the raising and acclimatizing of coffee, tea, cinchona, pepper, also rubber and cacao. All these products are now neglected more or less in favour of cacao and coco-nuts. The last mentioned have prevailed (although under English management there are some nice cacao estates in Samoa), and given the best results, probably because they were indigenous, and were brought to greater perfection by attention and scientific methods of modern cultivation.

For quite a number of years many small men of slender means were attracted to this field of enterprise, which promised rich rewards, and the figures quoted on p. 9 probably led to this development. The impetus thus given served well enough in a few fortunate cases where the planters did not experience any set-back and where all went smoothly from the start, but such were, however, by no means the general rule—rather the exception—and most of the small holders have disappeared by now, or have been absorbed by the big companies as managers, overseers, &c. The big company is now the order of the day, not only in the German Colonies, but all round, and some of these own areas carefully

planted with many hundreds of thousands of trees. They are run on the most modern lines and under up-to-date methods. To ensure success and increase the yields, costly experiments have been and are being carried on in connection with scientific manuring, and in some instances the attempted eradication of the lalang and buffalo grass has cost fortunes with little appreciable and beneficial results.

The Germans have taken their thoroughness and painstaking, methodical ways with them to the South Pacific Islands, and they are now slowly reaping the benefit in their steadily increasing exports of produce to the Fatherland and elsewhere.

As shown by Mr. O. W. Barrett in the section devoted to the Philippines, those islands, as indigenous producers of coco-nuts, and containing large areas of small lands producing them, stand "right first" in the coco-nut world. On this account we feel that a table of the cost of planting up coco-nut lands out there is worth studying, and certainly deserves attention, and have therefore included very full particulars in the Philippine section, for when the natives settle down to work, the islands will offer magnificent opportunities for agriculture and commerce, whether it be rubber, coco-nuts, or the old-time manila hemp. With modern methods and machinery, *plus* the Americanization of the Filipino, anyone and everyone interested in coco-nuts must pay the most careful

attention to those islands, whether you go there or elsewhere to plant. For these reasons, in the very near future, the output of Philippine copra, already of prime importance, will play as important a part in the soap and edible-butter world as the Gold Coast cacao is doing to-day in the case of chocolate and manufactured cacaos.

The cost of production, the output, and selling value of these islands must therefore be carefully watched by coco-nut planters and consumers, no matter who they are or where they may be.

NATIVE OWNERSHIP AND HUSBANDRY.

WHEREVER human settlement has taken place in coco-nut producing lands, there the trees are certain to abound. In the great majority of cases it was, and still is, everywhere a small ownership arrangement, every man to his few trees, just sufficient for his individual needs and those of his family, among whom the trees are carefully portioned out to be looked after. To such people the most highly-prized heirloom is a small grove of coco-nut trees. In some few isolated communities the trees would be held, planted, and garnered conjointly as on the South coast of New Guinea and the Islands of the Torres Straits.

The coco-nut forms an object of worship, and is revered and endowed with beneficial influences in many regions. And small wonder, for there is hardly one item of daily need that it does not furnish.

Search any canoe you like, and you will surely find some coco-nut products in it; it is food and drink as well. There is not a meal in the native dietary but what this nut forms some ingredient. It lends itself to being eaten raw, cooked, stewed, and grated.

The primitive aborigines on the Islands in the Bay of Bengal, the Andamans and Nicobars mostly consume it in the raw state. The Selungs on the Islands off the Burmese coast are still lower in the scale, because they add to it raw fish, and they do not trouble to build houses, but just cover in their canoes with the leaf-fronds roughly tied together over the top so as to form a sort of indifferent shelter against the sun and rain. This raw dietary, when long continued, is the cause of hideous skin diseases and leprosy. We find the same deplorable state of affairs existing on some of the Islands of the Torres Straits and on the outer Atolls in the South Pacific; and it is among some of these far-off places that we find almost the lowest types of humanity. But there are only fragmentary lots of them left, and these are rapidly dying out and disappearing from our ken. Such people must be reckoned among the casuals of the human race. They just happened, and seem to have escaped or been forgotten in the evolution of mankind; they never have achieved nor will they achieve anything, but will go on until swallowed back into the unknown with no regret and no tangible evidence of the why and the wherefore. What the sad remnants are, and where they really belong, has ever been a sore puzzle to anthropological researchers.

The small husbandman of the Isles has, as

a rule, a couple of dozen coco-nut trees to his name. Perhaps through marriage or inheritance the family he is head and patriarch of have brought some more into the store, and then the family is well off. The surplus of the nuts is made into copra, and, sun-dried or fire-dried, is bartered away at his own door, or taken with the lot of a neighbour to the nearest trade depot. Each man may have but a few pounds or hundredweights, but out of a little gathered together grows much. The multitude makes the quantity, and the puny supplies coming in from all sides in a constant stream eventually fill the storehouses of the trader and the holds of the ships which sail away with the product. Even here there is a gradual piling up; first comes the tiny native prahu with a Chinaman or Arab as owner. They go from house to house, as it were, and collect their little cargo of twenty to a hundred bags of copra. These tongkangs take the produce to the nearest port where the coasting steamer calls, from whence the buyer collects and consigns the bulked lot, which he has purchased from many native vessels, to the big emporium at Singapore, Batavia, or other large centres, and from these ports sail the ocean freighters with the cargoes of many coasters swallowed up in their enormous maws. This manifold inter-trading method of handling the copra will probably never change in thousands of little inlets and creeks, and nooks and

corners, where even, with the most carefully-organized service, the steamers either cannot go, or where it would not pay them to go on account of the smallness of the lots which it would be possible to bring together. We once made a coasting trip in a Dutch mail-boat through the Lesser Moluccas, during which we visited altogether thirty-seven different ports *en route*. The capacity of the boat was only about 850 tons, yet at the end of the voyage she was not quite full, although there was not a port we touched at but which furnished its quota of copra, besides other produce taken on board. Such trade copra is by no means the clean, wholesome, and pleasant-smelling stuff we see in Ceylon and in India. It is rank, pungent, and covered with mould; it certainly is not fit for articles intended for human consumption, and no amount of purification can really make it so.

Throughout a century or more no one thought it worth while to alter this, and the copra was accepted as it came to hand, and shipped as received. At the consuming centres such material was used without much more than an occasional grumble when it arrived at home in too putrid a state to be any good at all for any purpose whatsoever.

Intense competition and demand spurred first of all the merchants in Ceylon, and on the Malabar Coast in India, to something better. This need of improvement became

really urgent when an appreciable and later on a strong demand arose in the European and American markets for clear comestible oil, desiccated coco-nut and copra for human consumption. If the truth is told, it will probably be found that the initiative for this improvement was mainly due to America. Now that it has set in, it is pursuing its steady progress Eastward.

Once India and Ceylon showed the way, and it was noticed that they reaped a magnificent reward for their foresight and enterprise, other centres were forced to follow the lead given them, and those that did not had either to sell at very low prices in comparison, or find that their goods were altogether rejected as too bad.

The reputation for excellence thus won by the merchants of Colombo, Malabar, and Cochin, &c., continues, so that their carefully prepared products still enjoy the highest prices—as shown below, and also prices for 1913 at the end of the book—and it will be a hard but creditable struggle for the others to attain the same standard, much more to keep it, and keep it unchallenged.

COMPARATIVE VALUES OF COCO-NUT AND SOYA BEAN PRODUCTS AT THE BEGINNING OF APRIL, 1912.

Copra. — Manila, May-June, £24 7s. 6d. paid. Cebu, April-May, £25 7s. 6d. sellers. Java, April - June, £25 17s. 6d. buyers

Northern Ports net. South Sea Islands, April-May, £25 2s. 6d. value Continent; April-May, £25 value London. Malabar April - May, £27 10s. sellers. Ceylon, April-May, £27 2s. 6d. sellers Northern Ports and F.M.S. Straits; April-May, £26 sellers Northern Ports, and F.M.; May-June, £25 7s. 6d. sellers c.f. and i., delivered weight.

Soya Beans.—Harbin parcels spot, £7 16s. 3d. Hull, afloat, £7 17s. 6d.; March-April, £8 2s. 6d.; June-July, £8 2s. 6d.; Cargoes afloat, £7 18s. 9d.; March-April, £8 2s. 6d. June-July, £8 5s. sellers.

Coir Fibre, per ton :—

	1911.					1912.			
Cochin, fair to fine	£17	0	£22	0	...	£17	0	£23	0
Ordinary to middling	9	0	15	0	...	8	0	15	0
Ceylon	10	0	14	0	...	8	0	12	10
Bristle, Ceylon ...	18	0	26	0	...	13	10	26	0
Rope	13	0	20	0	...	11	10	18	0
Yarn, Cochin, superior	27	0	32	0	...	25	0	29	0
Good to fine weaving	23	0	26	0	...	21	0	25	0
Medium to good medium	18	0	22	0	...	12	10	19	0
Low and ordinary, coarse	10	0	15	15	...	9	0	15	15
Mat and roping...	8	10	14	0	...	8	10	14	0
Ceylon, fine and superior	24	0	28	0	...	23	0	28	0
Ordinary to good	16	0	23	0	...	14	0	22	0

Coco-nut Oil.—Ceylon spot, £41 10s.; March-April, £38 15s. c.i.f.; April-May, £38 15s.

c.i.f. Cochin spot, £46; March-May, £41 5s.; April-May, £41 c.i.f.

Soya Oil.—London: Barrels spot, £27 5s. (prompt sold at £27); Hull, spot crushed, £24 10s.; May-August, £24 15s.; Oriental (in cases) January-February, £24 15s. c.i.f.; February-March, £24 15s. c.i.f.; March-April, £24 12s. 6d. c.i.f.; April-May, £24 10s. c.i.f.

It is quite true that the laurels were not won in a day nor yet in a few years, and no one denies but that the result was the outcome of steady effort and endeavour. Whether the planters at other centres are handicapped because their nuts are inferior to those of India and Ceylon is by no means proven; but even if this is so, when once the same care and solicitude have been expended by the backward ones, both on the trees as well as on the copra, as is done by their rivals, then it will be time enough to talk of handicaps.

For some reason or other, Ceylon especially has been a favoured child of Fortune, and capital and enterprise have preferably gone there, to the detriment at times of other regions, which are, in themselves, equally, if not better, favoured by Nature. The reason may lie in the charm of the land, but the enterprise and thoroughness of its European planters certainly have a great deal to do with this, as was the case when the same men started to plant up Malaya with rubber. The true Ceylon planter had only to whistle and the money came like

rain ; others followed in their wake, but not always with the same advantage to the investing public. It was the Ceylon men, helped perhaps by their fellow-planters in India, that gave the boon its reputable, creditable side. Another main reason may be owing to the fact that she is placed directly upon the highway of the greatest ocean route—that from the Far East to Europe—and, up to the time of writing, to America as well. The Panama Canal may make a lot of difference, as it should cause the West India Islands to become favoured centres in an equally striking manner. Personally, we sincerely hope it will, but meanwhile Ceylon remains the favourite.

Take Java, for contrast. Here we have probably the most-favoured-by-Nature centre on earth, and at the same time one of the largest, if not the largest, islands in the Tropics. She has over 30 millions of teeming, diligent, and thrifty natives ; yet, because she lies away off the main route, up to now she has not received an equal share of attention. It is true that the Hollanders have done wonders with the marvellous material placed in their hands, but they must yield the palm to the "spicy isle" for general recognition from the world at large.

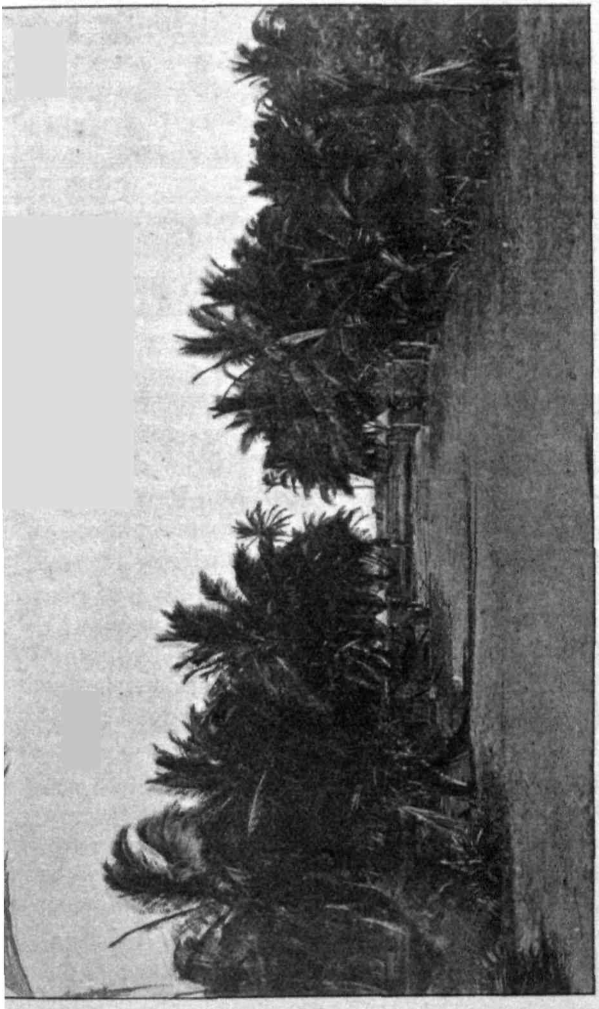
The Ceylon planter deserves his fame ; the men who went through the coffee plague of the eighties with spirits undaunted were not the ones to give up in despair and go elsewhere.

They turned their minds and energies to other things, and made a success because they brought system and intelligence to bear on their undertakings. Theirs is an example that could well be held up to, and followed by, many a weak-kneed bread-winner at home as well as in the Tropics. On the other hand, the bulk of the native population of Ceylon has always been a sore trial to the men who have attempted to make something of them, as they have done of the island. Indolent, flighty and treacherous, hard, honest work with the majority of them seems to be anathema. Possibly this majority own a small patrimony just sufficient to keep them from want, but it can be no more than barely sufficing; yet although there are over seven millions of such "lotus eaters" in the island, the bulk of the labour to work the plantations has to be brought from outside, and it is lucky for the white planters that they have the teeming and willing multitudes of the adjacent Madras Presidency to draw upon. But the query is—will this supply last? What will happen when these thousands of Indian coolie labourers are needed in their own land is too gloomy to dwell upon, from the Ceylon planter's point of view. One can only hope that they will never be faced with such a dilemma; but when the fatal day arrives—if it ever does—no doubt they will be quite equal to overcoming it.

SELECTION OF A LOCALITY AND SITE FOR A PLANTATION.

When we take into consideration the fact that from the planting of the seed-nuts, it takes the best part of a decade for a coco-nut plantation to arrive at maturity, it will appear obvious to anyone that the greatest possible amount of care must be exercised in the initial selection of the locality as well as in the soil itself; also that all other concomitant factors making for and promising ultimate success be carefully considered.

For the planting up of a coco-nut estate does not only involve a lot of time, but a considerable amount of money as well, which may be sunk irretrievably or invested profitably according to the care which has been bestowed at the outset upon these important desiderata. First of all, then, it is perfectly useless to look around anywhere outside the meridians of Capricorn and Cancer, much better well within them. A sea climate is the best, because it does not present great varieties and excesses of heat and cold, and also feeds the palms with constant supplies of water so necessary for their well-being, without any chance of the soil becoming sour and water-



COCO-NUTS TEN YEARS OLD, ON THE CIE. DU BOROR'S "PORTO BELLO ESTATE," ZAMBESIA.

In laying out their estates this Company, which claims to have 700,000 trees in bearing or coming along, has taken the precaution to divide the areas into separate estates, some distance apart, so as to avoid epidemics of pests or disease running through all the trees.

logged. Mountainous regions are tabooed, and so also are localities with a torrid and dry temperature.

Proximity to the sea has also the great initial advantage, apart from other considerations which have to do with the growth of the trees, in that it offers, with very few exceptions, a much greater degree of shipping facilities. This is an item of high value, because all the products of the coco-nut palm, be they copra, oil, or fibre, are heavy and bulky; and long, difficult distances are against success, or, at least, they tend to seriously reduce the profits. It has been proved by long practice, and is, in fact, evident on every hand, that the farther one goes back from the sea-shore, the less abundant and well-looking do the coco-nut trees become, until at about 125 to 150 miles inland one only meets, as a rule, isolated, attenuated specimens. Even the banks of large rivers do not seem to make any difference to this rule, probably on account of the soil, which is generally muddy and close, not porous and sandy.

O. W. Barrett, in his Farmer's Bulletin No. 17, speaks of planting coco-nuts near lagoons, or swamps, when he tells us: "Although coco-nuts are killed by salt water covering the 'feeding area,' as well as by stagnant fresh water over their roots, they may be planted without much danger close to salt-water lagoons, especially if low earth dykes are

thrown up along the margin of the lagoon to hold back the highest tides."

The only fairly thriving colony of coco-nuts far inland which we know of is at Tabora, in German East Africa, which is over 300 miles from the seashore, and on a high tableland to boot, nearly 3,000 ft. up. In spite of this fact, whilst coco-nut trees are very rarely met with, and do not, as a rule, thrive at an altitude of over 1,200 to 1,500 ft.; and while it is true that we have small groves of fairly good trees at Kandy, Ceylon, 1,760 ft. up; at Buitenzorg, Java, at an elevation of 2,100 ft.; and also on high lands in Fiji, Samoa, Honolulu, &c.; of real plantations we have none at such elevations, and nobody in his senses would try to establish one at such altitudes. Having now reduced our possible area to a fairly well-defined limit, outside of which it would not be safe to go, we will proceed. It is agreed, therefore, that the best and most important estates occur near the sea upon fairly level land where important mountain formations in the vicinity of frequent rivers and torrents have formed huge deposits of rich, friable soil. To these deposits are added the accumulations of humus created by the vast decomposition of plant growth, decaying in all its prolific luxuriance through the uncounted ages. Where there are considerable formations of mother-rock cropping up through these alluvials, it is well to form a correct

estimate of their extent over a given area; for these have to be eliminated altogether in the planting, unless they lie sufficiently deep, say over 10 ft., to do no harm. If they are level and impervious, they will probably hold ground water, which is bad. Heavy clay and "sour soils" are to be carefully eschewed, because they are extremely bad carriers of water, and the roots, owing to chronic "wet feet," are certain to rot under such conditions.

Talking of percolation of soils suggests the most advantageous conditions of rainfall, for too much water can be harmful, the same as too little. Without proper drainage too much rain will tend to develop the trunk and leaves at the expense of the fruit, while the reverse will, of course, be harmful to both.

It may be safely assumed that a volume of 50 to 80 in. annually, well distributed through the seasons, is the best of all, provided the subsoil below retains the moisture, and keeps the top soil moist. The range of the thermometer should not be too great; never below 55° F., and seldom above 90° F., is the happiest condition. Almost wholly level land, with a sufficient slope and gentle undulation to ensure perfect drainage, is the ideal location for a coco-nut plantation, provided the soil consists of a good layer of humus and porous soil underneath, plus, of course, a good supply of water always on the move, never resting

stagnant. It will amply repay the inquirer and intending planter to satisfy himself thoroughly regarding these desiderata before purchasing land, by going to the trouble and expense of sinking test-holes at frequent intervals all over the area under contemplation of purchase, where surface indications are not palpably evident as to the nature of the estate.

A very tangible proof of the fertility or otherwise of a region is in all cases the state of the surface growth. Where you find large and flourishing trees and herbage, there you may be sure that ideal conditions exist for your purpose; this surface growth, however, may have been destroyed by some agency not readily discoverable, and then of course it is necessary to employ the soil tests. If one contemplates having this analysed it is always to be recommended to make the samples of not less size than 5 lb. or even more, and many recommend a cubic foot taken from varying depths and spots as being best. If lime is found in your investigations it is a valuable asset, especially for fruit production. With many centres, especially islands where the primary coral formation has been lifted considerably above sea-level and later on covered with fertile earth to a remarkable thickness (as on the East Coast of Africa and adjacent islands), lands very suitable for coco-nut cultivation are often to be picked up cheap. Such situations are sometimes, however, extremely isolated, so

that even if the profit is good, many, and perhaps most people, prefer to go elsewhere and pay more. Now mark carefully: If you should find that the surface growth has been eradicated by hurricanes, and if you learn that these occur frequently in the localities you have marked out, then strike your tent and proceed elsewhere, for you are in the cyclone-belt, where the labour and care of many years may be swept away and utterly annihilated in half an hour. It is true that these destructive gales are of small radius, and like lightning (so it is erroneously claimed) may not strike in the same place twice for many years, but years pass quickly, and there is always the awful risk, so that the careful investor is better away from it, for even one visitation in a lifetime is more than most men want. These hurricanes, or cyclones rather, occur in belts, and their zone of activity is better defined in some regions than in others. Speaking in a general sense, those regions lying between the 13th and 18th degrees of latitude on both sides of the Equator are the most frequently and disastrously visited by cyclones. In some localities they recur almost every third or fourth year with ominous regularity.

Earthquakes also now and then play widespread havoc, and these are most to be feared in the Molucca Seas, where the extensive volcanic systems of Java and the Flores Sea, &c., exist and make merry to mankind's

discomfort. We will only mention here the appalling disaster of Karakatoa Island, in Anjer Strait, West Java, which swallowed up an entire island, cost many thousands of lives, and destroyed the vegetation for hundreds of square miles. This was in July, 1883. And although nothing approaching this in seriousness has happened since then, the potentialities are always present.

But the "visitation of God" is always with us, wherever we may be on this planet of ours, and although such menaces do not and will not deter the stout-hearted from venturing their all, and entrusting themselves to the call and the glamour of the vivid and fervid Tropics, it is best to avoid them when possible, for if it is true that: "Only the Brave deserve the Fair," it is equally true that "Discretion is the better part of Valour." Inundations, provided they are not of protracted duration, and the water drains away, do not seem to have any deleterious effect upon the growth and well-being of coco-nut palms. Where these are caused by rivers, they would naturally do more damage, if accompanied by any strength of current, sufficient say to uproot some of the trees, which happens at times, because the roots spread wide around, rather than go to any appreciable depth; neither have they any great strength.

The root system of a full-grown coco-nut tree extends radially to 20 and even 25 ft. around

the trunk. These roots and rootlets are thin, long-stretched and bulbous, eminently suited and constructed to suck up the nourishment and moisture from sand and the surrounding ground. This accounts for the fact that one sees many good and healthy-looking trees growing on the bare sand right down to the water's edge, which spots, apparently, should offer no sustenance at all.

In all such cases, however, one may be sure that the rootlets are tapping the subsoil waters flowing subterraneously from further inland, which in their passage come laden with highly-nutritious plant foods. It is not judicious to plant coco-nut trees upon slopes of any steep grade, because in such positions the tree would not have so good a purchase, nor be so well balanced, as it demands in an extraordinary degree, on account of its imposing height and the heavy foliage set on the top of its slender trunk.

It is not uncommon for such a trunk to reach a height of 80 to 100 ft., with a diameter of only a couple of feet perhaps just above the ground, and it might be only 1 ft. to 18 in. In spite of this the trunk, though apparently made of such flimsy cellular material that it seems a wonder it can with safety uphold its length and proud crown, has so strong an internal structure, which in many ways is like the stays and shrouds of a ship's mast, that its tenacity and strength are capable of

great resistance, and though it will bend and never recover its upright position, yet it does not break.

It has been truly said that not a particle of the coco-nut tree is without its uses in some fashion or other, yet a use for the trunk in native economics is hard to find, for only a few narrow boards, that do not last too long, can be cut from the outer layers of it, whilst the interior is no use for timber. With the other parts it is quite a different matter, all of them enter very largely into domestic use. The fronds of the leaves are used in various ways, but principally for making "attaps." These are the fronds bent double over 4 ft. sticks and laced through. They are then used to make the roof of the house, as well as for the walls, the interior partitions, the windows, doors and fences.

In a green state the leaves are woven into baskets so closely that rice is cooked in them, and they are also used for ropes. The mid-ribs of the leaves are used for utensils and fishing-gear and the most pleasantly remembered use is for spearing whitebait upon for a roast and for a "sarteh" (bits of pork and fowl and venison strung upon these ribs, and then dipped into chili-sauce and grilled).

The stem of the leaf enters largely into house construction, fencing and bridging, and short pieces of the butt are used for floats on nets. It would take pages to describe

adequately all the really useful purposes which the various parts of a coco-nut tree can be put to, and these if included at all must be left for the end of the book; they would certainly be out of place here.

COCO-NUT CULTIVATION IN CEYLON.

As Ceylon occupies so important a position in the coco-nut world, both on account of the quantity produced as well as of the ceaseless attention devoted to agriculture generally, our readers will be pleased to note the following remarks made by Mr. A. W. Beven on the subject of coco-nut planting, at the Annual General Meeting of the Ceylon Agricultural Society, June, 1911, calling attention to the great importance attached by him to thoroughly cultivating, draining, and manuring coco-nut lands. We quite agree with all Mr. Beven says, but there are many who maintain that in order to properly cultivate the land, the roots must, or may be, disturbed and damaged, and through them the tree. This surely need not be to such a degree as to cause cultivation to be "tabooed" entirely; Mr. Beven evidently agrees with us. We would add that all the footnotes are ours.

"With coco-nuts, cultivation should commence immediately after planting. General rules will not apply, for some estates have hard gravelly soils, some heavy clayey alluviums, some loamy clay, some clayey

loams, and others sandy soils varying in colour from a red sand to the white cinnamon garden sand, called by the Singalese 'maradan vella.'

"As regards *planting*, the usual method is to cut holes of 3 ft. cube, or of other dimensions, according to individual idiosyncrasies. At the bottom of these holes a little surface soil is thrown in, and on this the plants are placed. There are objections to this general system. In wet weather the holes get filled up with water, and if the wet weather be continuous, the plants get drowned. A second and greater objection is that the soil round the plants cannot be tilled by being loosened with mamoties, so as to give the plants a good start, as the roots are below the reach of cultivation till trunks are formed.

"The system I adopted, when I took to coco-nut cultivation thirty years ago, was to cut holes 3 ft. cube, and to fill them with the surface soil cut from their sides to within one foot of the surface. By this means the holes become saucer-shaped, and are about 5 ft. in diameter. Cultivation can, by this system, commence almost immediately after planting, and can be continued in an increasing circle with the growth of the plants and the spread of the roots. I was very gratified to find there was one other who followed this system, *viz.*, Mudaliyar A. E. Rajapakse, on his Eheta estate, through which the Negombo

line runs. Some people express the fear that by putting down the plants so near the surface the stability of the tree will be affected. There is no fear of that, for the bole of the tree, which is its sheet anchor, and takes the place of the tap root of other trees, will establish itself in the original hole, and even deeper, according to the texture of the soil.

"The next operation calling for attention is weeding. This should be undertaken soon after planting. If the estate be weeded from the start, weeding will not cost much, and a beautiful sward will cover the ground. Most estates are planted on the *goiya* system, that is, the land is given to villagers to fell, burn, clear, and plant, and they are allowed a share of the subsidiary crops grown on the land, besides being paid at so much per tree and plant (previously agreed upon) at the end of a specified number of years. This system has its advantages and disadvantages. The advantages are obvious. One disadvantage is that the villagers do not supply vacancies till the time arrives for giving over.[1] Then the landowner has an estate with a large proportion of plants just put out. Some experienced planters think that minor cultivation impoverishes the soil and should not be

[1] Surely this difficulty can be overcome in the agreement, which is binding on both parties; a magistrate's court, when necessary, being used to settle alleged breaches of contract on either side.

practised.[1] This it undoubtedly does, but not to an extent to be detrimental to the coco-nut plantation, particularly when manuring is practised. As against the impoverishment of the soil, there is the benefit accruing to it from constant tillage. In dry districts, cotton could be grown as a subsidiary crop.

"Every time the land is weeded, or at least once a year, the soil should be tilled in an increasing circle round the plants and mulched with weeds, which should be placed at least a foot or 18 in. away from the plants to avoid trouble with black ants. All laggards and recent supplies should have a large coco-nut shell full of kainit. When, in course of time, the edges of the tilled circle touch each other, the intervening spaces should also be tilled. Probably by this time the estate will have come into bearing, as a result of continuous tillage. After this the land can be ploughed.[2] Efficient ploughing is not practicable on any but sandy soil, unless tilling precedes it. The land should be harrowed the year after tilling. These operations should be carried on in alternate years, so as to have the soil always in a fine state of tilth. Unfortunately, everyone does not realize the benefits of having the soil in a friable state. If brought into this condition, most of the

[1] Quite right, and if financially necessary, the catch crops must only be planted for an agreed number of years.

[2] Anti-ploughers please note.

rain-water is absorbed by the soil; and air is drawn in after it. The soil, therefore, becomes aerated to a greater depth than the furrows made by the plough. Roots traverse further and deeper, and find their way to the regions of permanent moisture. The loose soil on the surface acts as a mulch and prevents the evaporation of moisture. The roots having gone deeper and evaporation having been arrested, it follows, of course, that coco-nut trees are better able to withstand droughts and to bear and mature better crops. The aeration of the soil renders soluble the otherwise insoluble plant food in the soil. Planters of experience, who have not made a study of agricultural chemistry, realize the benefits of a thorough aeration of the soil so little that recently a gentleman wrote to me and complained of the drought and its effects, as seen in the dropping of immature nuts. I suggested the procedure I have just explained, also a thick cover of *Crotalaria.* He wrote in reply: 'Thanks for your suggestions about ploughing, which I wish I could carry out more fully, though nothing will prevent the nuts being burnt in such weather as we are having, and the droppings from the young trees in the harder soils.' He should not be too sure of the impossibility of overcoming these untoward results of drought. None of us are too old to learn. A few acres might be experimented on, and the results watched and reported.

"*Draining* should be taken in hand as early as possible. The object of draining coco-nut estates on hard soil, and land with an undulating lie, is the opposite of what it is on up-country estates. On coco-nut estates the cutting of drains or trenches should be to catch all the rain-water that falls on it, and to allow it to pass *through*, not *over*, the soil. On up-country estates contour drains are cut to carry away the rain-water. This is necessary, as the rainfall up-country is heavy, and the lie of the land is generally steep. If the soil be too saturated with water, there will be the fear of whole hillsides sliding into the valleys, especially where the soil overlies slab rock.

"The draining I am, however, referring to is different from the draining of low ground, which is generally done when lands are opened and planted to drain off superfluous moisture. I lay great stress on the absolute necessity for catch-water drains on undulating land and for hard soils. There are two systems in vogue. The most common one, and that usually practised by villagers, is to throw the soil out from drains on their upper side. This system is more correctly terracing. The soil being thrown on the upper side of the drain effectually prevents rain-water finding its way into them. Rain-water and silt are arrested by the banks of earth, and find their way out at the lowest level. What I preach and

practise is for drains to be cut as nearly as possible at right angles to the slope of the land, irrespective of the lines of the coco-nut trees. The earth should be formed into a bank on the lower side, so as to increase the capacity of the drain to catch water. They should not be of one continuous length, as, unless they are traced and cut absolutely level, the arrested water will find an outlet at the lowest point, and the remedy will prove worse than the disorder it was meant to cure. The drains should be cut in sections about 25 ft., leaving intervals of about 18 in. between the sections. The bottom of the drain should be so made that the water from one section should not find its way into another. The ends of the drain should be slightly rounded to prevent the water flowing out.

"These drains can be gradually filled up with husks, coco-nut branches, and weeds, and when quite full, must be covered over and new ones should be cut. Another benefit of these drains is that they help toward the aeration of the soil. Drains are useful on flat land as well, whatever the texture of the soil. They can be used as receptacles for the husks and branches, which, in decaying, enrich the soil. In such places the drains should be wide and shallow, so that a large surface may be enriched with humus. Here, too, new drains should replace those that are filled up and covered over.

"*Liming*, a very necessary branch of agriculture, is almost entirely neglected in Ceylon. I do not intend writing a dissertation on lime, though a paper could be written exclusively on this one subject. The action of lime on soil is partly physical and partly chemical. It gives cohesion to a light sandy soil, and renders a hard soil friable. It is specially useful on alluvial and clayey soil. By its chemical action it sets free plant food which exists in an insoluble condition. Perhaps its most important attribute is that it assists the work of nitrifying bacteria. It should be applied to the land after it has been tilled or ploughed, and to trees a few months before the application of manure, so that it may have time to revert to the carbonate form by the action of the atmosphere and rain. Unless this chemical change occurs, the nitrogen in the manure to be applied will be dissipated as ammonia. The action of manure will be increased by a previous application of lime to the soil. Now, as to the quantity of lime that should be applied per acre. In European agriculture it used to be applied at the rate of six to eight tons per acre at intervals of five to six years, but I believe this harmful system has now been abandoned. I advised a gentleman who consulted me about the treatment of a heavy alluvial soil to apply about 10 bushels of lime per acre biennially. He was more than

pleased with the result of the first application in the improved texture of the soil. It became quite friable. Whether he is continuing the application I cannot say. I think 10 to 12 bushels per acre, according to the texture of the soil, every alternate year, after ploughing and a few months before the application of manure, will give encouraging results.

"*Manuring* is the returning to the soil of the elements of fertility removed from it by cropping. The soil has been aptly likened to a bank in which the amount of credit is measured by its fertility. Crops are drafts on the bank. Their removal, without returning the equivalent in the shape of manure, results in the diminution of the amount at credit, or, in other words, in the impoverishment of the soil. Accepting the definition of manuring at the beginning of this paragraph, I have in practice always endeavoured to return to the soil the elements of fertility removed by crops. The soil is drawn upon, not only to mature crops, but also for the growth of the tree and for the production of the fronds. Unless the soil is exceptionally poor, the elements of fertility in it may be sufficient for the tree and fronds, but not to produce marketable nuts. In practice I have found that a manure based on an analysis of the soil did not yield anything like the same results as a manure based entirely on the elements of fertility removed by the crops. The earliest

analyses of the coco-nut tree and its products were made by a Frenchman, Lepine. They were most elaborate, but have not been accepted as accurate. I see that they are omitted from the latest edition of 'All about Coco-nut Planting.' To my knowledge the next analysis was by Cochrane, at that time the City Analyst of the Colombo Municipality. He interested himself much in agricultural subjects, and published a very useful book, 'Ceylon Manual of Chemical Analyses.' His analysis of 3,000 coco-nuts, representing the crop of one acre, was as under:—

	lb.
Nitrogen	50·25
Phosphoric acid	21·64
Potash	101·25
Salt	63·75

"The next, I believe, was by Bachofen, at the time in the employ of Mr. Baur:—

	lb.
Nitrogen	25·97
Phosphoric acid	7·35
Potash	56·25
Salt	64·26

"The next I have is from the *Philippine Agricultural Journal*:—

	lb.
Nitrogen	56·04
Potash	57·09
Phosphoric acid	15·78

"It will be noted that, except as regards salt, Bachofen's analysis gives about a half of the

other constituents as compared with Cochrane's and one-third of phosphoric acid. In the *Philippine Agricultural Journal* analysis the amount of nitrogen is slightly in excess of that of Cochrane's. The potash is practically the same as in Bachofen's. The phosphoric acid is a mean between Cochrane's and Bachofen's. The manure I have used, and with encouraging results, is based on Cochrane's analysis. I attribute the good results to the quantity of potash in the mixture, which is deficient in the soil to which I have applied it.

"Cattle manure renders valuable assistance in coco-nut cultivation, whether on hard or sandy soils. In its decay it adds humus to the land, and the quantity of humus in a soil is the measure of its fertility. Hard soils are rendered friable with the addition of cattle manure, and it gives body and retentiveness of moisture to a light sandy soil. Where there is sufficient pasturage to maintain a herd of cattle, these, when tied to the coco-nut trees, give very encouraging results, as the solid contents of their droppings add to the humus, and the valuable liquid contained therein drains into, and is absorbed by the soil if it is porous. Evaporation can be arrested by the use of fibre dust or any vegetable matter spread round the trees to which cattle are being tethered. Wherever cattle manure or cattle droppings are applied, half the quantity of artificial manure is usually sufficient. Where

cattle manure is not available, *Crotalaria* will be found to be a very useful substitute for the formation of humus. In common with other leguminous plants, it has the further valuable property of being able to appropriate nitrogen from the atmosphere to enrich the soil. All green matter, whether leguminous or not, should be buried so as to enrich the soil.

"Analysis of the soil will be useful to find out whether it is acid; if so this can, to a very large extent, be corrected if the treatment before suggested of tilling and liming the soil be carried out; analysis also finds out whether the soil is deficient in any constituents, for, according to the 'Law of the Minimum,' if the soil be very rich in all the necessary constituents of fertility and be deficient in one, even the most unimportant, the crop will be adversely affected.

"If the fronds be cut up, heaped and burnt, and the husks be removed to the different fields and be burnt or buried, the elements of fertility removed from the soil will be represented only by the nuts. The transport of husks to be burnt will be a costly item in the expenditure. If means could be devised to burn them where the nuts are heaped,[1] without damaging the surrounding trees, the cost of transport will be diminished. If the husks be buried, the

[1] As by the incinerators described in the section on Pests.

resulting benefit to the trees will commence with their decay. On a heavy soil, retentive of moisture, the decay will be comparatively rapid, while on a sandy soil the decay will be very slow. If the husks are buried in small pits all over the estate, they will, in decaying, yield humus, which is essential to a fertile condition. Another source of humus is weeds, which it will be wise to always fill into small pits. Humus and its formation have received much attention in recent years, since the growth of nitrogen-gathering legumes was suggested, and *Crotalaria* is perhaps the most popular of all leguminous plants. One drawback with the cultivation of large leguminous plants is that the whole surface of the soil does not get the benefit of the humus, only the pits where they are buried. Cannot planters introduce some species of small plants, like vetches or lupines, which can be readily turned into the soil in the process of ploughing or tilling?"

COCO-NUT CULTIVATION IN MALAYA.

Mr. T. C. Noch, Acting Inspector of Coco-nut Plantations, includes the following remarks in his report on coco-nut plantations, in the annual report of the Director of Agriculture, Federated Malay States, for the year 1910:—

"It seems to have dawned upon the Europeans at last, now so much interested in rubber, that it would be well to have two strings to their bow; and where could be found, considering the very favourable conditions under which coco-nuts grow on the flat alluvial land near the coast, a safer or sounder investment than the cultivation of the 'Consols of the East'?

"The area under coco-nuts in the Federated Malay States, at the end of 1910, I estimate, approximately, at 130,344 acres, and I value the whole at \$29,000,000 = \$222½ per acre (\$1 = 2s. 4d.). White ants destroyed about 100 trees in the Lower Perak district, whilst squirrels and pigs do a good deal of damage. In the State of Negri Sembilan bears and squirrels were very destructive, the same as in previous years. In Selangor a caterpillar pest made its appearance, but although many of

the trees were defoliated, they rapidly recovered. Spraying is, of course, the remedy, but it is only possible to spray the higher portions of the trees with a very powerful machine.

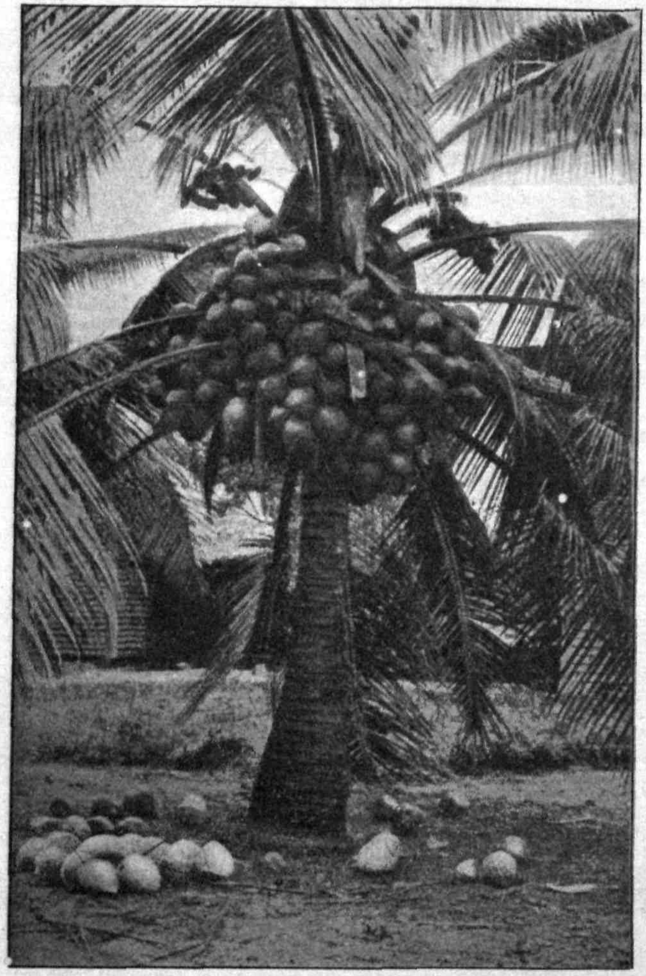
"The total export of copra was 125,770 piculs (1 picul = $133\frac{1}{3}$ lb.), an increase of 16 per cent. over 1909. This, of course, does not represent nearly the whole of the production. In Negri Sembilan, for instance, the greater part of the produce is sold as nuts and converted into copra in Malacca. The price of the nuts in Selangor has risen from two and a-half to five and six cents each, owing to the increased demand by Chinese merchants who make copra.

"The area under coco-nuts in the four States is returned as being as follows:—

	Area		Exports[1]	
Perak	66,088 acres	...	91,265 piculs	
Selangor ...	28,667 ,,	...	31,451 ,,	
Pahang ...	19,246 ,,	...	2,585 ,,	
Negri Sembilan	16,343 ,,	...	469 ,,	
	130,344 ,,	...	125,770 ,,	= 7,500 tons."

Prices of the nuts in Malaya varied considerably from two to six cents each (100 cents = 2s. 4d.), against an average price of

[1] As already mentioned, the quantity exported is but a portion of the total production. The produce of any increased area coming into bearing would tend to go almost entirely, we should imagine, to swell the exports, as the local demand has already been satisfied out of the present output, so any increase to this would have to look to oversea markets for buyers.



How Coco-nut Trees yield in the Federated Malay States.

Specimen of a tree from the Klanang Estate, Jugra, carrying 360 nuts at a time.

2·4 cents each (100 cents = 4s. 2d.) in Trinidad, W.I. ($24.25 per 1,000), for picked nuts in bags of 100 f.o.b. Port of Spain.

The average value (in F.M.S.) during 1910 for copra was $9.50 = about 22s. 2d. per picul (133⅓ lb.), against $4.96 (19s. 6½d.) per 100 lb., the average price during 1910, in Trinidad, W.I. Whilst on this subject of prices, the following figures worked out on the basis of the fortnightly quotations of Messrs. Gordon, Grant and Co., Ltd., Port of Spain, Trinidad, W.I., may be of use.

Prices of the entire nuts, copra, and oil move quite independently of each other. Thus in Trinidad, oil, on May 28, 1910, stood at $1.09 a gallon, against $4.75 for copra, and $22 only for whole nuts, yet at the beginning of March, 1911, the nuts had advanced to $29, whilst oil was only quoted at 96 cents, and copra had dropped to $4.30. Quotations at the time of writing (April 1, 1912), stood at $29 for nuts, $1.06 for oil, and $4.65 for copra. In 1911 eleven quotations for nuts, starting January 1, gave an average price of $26.36½ per 1,000. The highest rate ruled during February and March, 1911, at $29; this dropped to $24 from mid-May to mid-July, and remained at $26 for a time. Oil started in 1911 at $1.08 per gallon, and gradually fell away to 75 cents on August 7, but recovered to 82 cents on August 21. Copra started at 4.50, rose to $4.75 during February, dropped

to $3.25 in May, then rose to $3.90 on August 21 ($1 always = 4s. 2d. in this instance). We cannot say what the record shipment from Port of Spain has been, but on July 14, 1911, a single vessel, the s.s. "Laila," took 1,150,000 nuts, consigned to Philadelphia. (For prices in October, 1913, see end of book.)

The *Tropical Agriculturist* of Colombo comments on shipments of coco-nut products from Ceylon during 1910. Of coco-nut oil 594,235 cwt. were shipped, being a record except in 1908, when 629,122 cwt. were exported. A record local price was established in Rs.605 f.o.b., but since then supplies of soya-beans are considered to have been responsible for lower values in Ceylon, America, and elsewhere. Of copra 719,262 cwt. were shipped, against 727,698 last year, or 8,436 cwt. less. The highest price realized was Rs.93.50 at Colombo (R. = 1s. 4d. about). Estate owners, as a rule, preferred selling their nut crops in shell, as they then realize a quicker return and no risk of a falling market. In this they shared the opinion of the Trinidad (W.I.) planters, who were then realizing $29 per 1,000 for "standard peeled select," in bags of 100, against $4.30 per 100 lb. for copra ($ = 4s. 2d.) and 91 cents. per gallon for coco-nut oil. As we have the figures by us, our readers may be interested to see the Trinidad prices and shipments since 1908, which compare as follows:—

PORT OF SPAIN (TRINIDAD).[1]

	Total shipmt. Nuts only	Price[2] Nuts	Price[3] Oil	Price[4] Copra
Apr. 3, 1911, 3 months	3,433,642	$29	$0.91	$4·30[5]
Dec. 31, 1910, 12 ,,	19,768,223	26	1.12	4·75
,, 31, 1909, 12 ,,	19,158,513	23	0.80	4.25
,, 31, 1908, 12 ,,	16,622,708	23	0.61	3.10

Ceylon, on the other hand, in 1910, shipped 15,941,826 nuts in shell, against 20,609,864 nuts during 1908, their best year. Prices ranged from Rs.64 to Rs.73.50, but in isolated cases touched Rs.75. December saw prices at Rs.63 (per 1,000) at the mills. Those who manufactured desiccated coco-nut complained of the prices realized during the early part of the year, and though it rose later in sympathy with oil and copra, it again fell to barely paying point. The demand also went slack, so that the mills either shut down or went slow. During 1910 26,171,159 lb. desiccated were exported, against 24,604,521 in 1909, and 26,486,222 lb. in 1908—the record year.

According to Consular reports prices for copra in Zanzibar in 1910 ranged between 4s. 6d. (the lowest for indifferent quality) and 8s. 7d. (the highest price for good quality

[1] *Ex* Messrs. Gordon Grant and Co's circular.

[2] Per 1,000 nuts, "standard selected," peeled, and in bags of 100

[3] Per gallon, cask included.

[4] Per 100 lb.

[5] It will be noted that local prices for the various products do not move in unison. On April 3, 1911, at the prices mentioned, preference was naturally given to selling the nuts in shell, when up to type.

copra) per frasila of 35 lb. Local prices do not fluctuate according to the output of the season, but move in sympathy with the European market. With the exception of small exports to Germany and Bombay in 1909, and to Italy and Germany in 1911, the shipments from Zanzibar apparently were made entirely to Marseilles.

Mr. L. C. Brown, Inspector of Coco-nut Plantations, F.M.S., estimated that the average price for coco-nuts at that centre during the five years, 1905-1909, had been a little over $30 per 1,000 ($ = 2s. 4d.) and of copra $8.65 a picul = 133⅓ lb. One thousand nuts on the average gave 4·30 piculs, in which case $30 worth of nuts collected (1,000 nuts) when turned into copra returned about $37.20, including the cost of extracting and drying the kernels. By the way, Mr. Brown states that when making copra, a better return is obtained if the nuts are stored for a month or so before being opened, and it lessens the cost of manufacture, as the kernel is then more easily extracted from the shell. We have always suggested putting the nuts in the sun to dry off a little, as that has the desired result of shrinking the kernel, so that, when the shell is broken, it is easily detached; meanwhile it all helps in the drying. The question of the best kind of dryer, when mechanical process is desired, is still far from settled, though all condemn sun-drying, if only because the copra tends to get

dirty, whilst drying over the grill is still worse. Experiments in the Philippines support our ideas that the rotary and tunnel systems of drying are the best, as the heat can be adjusted to a nicety, and packed away in trays or cylinders there is no chance, except through carelessness, of the copra getting dirty. If needed for edible butter, the meat cannot be kept too clean.

The other day we approached some very large buyers of copra and coco-nuts, who we knew grew and prepared a large portion of their requirements overseas, and put the following questions to them, which they very kindly answered, in reference to the *pros* and *cons* of mechanical dryers and of a rotary dryer in particular :—

Question.—Do you, on the whole, prefer sun-dried or mechanically dried copra, if equally free from mould?

Answer.—Providing the percentage of oil in the copra is equal, we prefer mechanically dried copra, but believe, as a rule, mechanically dried copra contains a less percentage of oil than sun-dried.[1]

[1] When this is so, we should say that it was the fault of the men behind the machine, not the machine itself, and is due to too rapid drying. Watch the sun on either cacao or copra, and see how it works. It makes it "sweat out" its moisture, and at the same time the more it does so, the more oily does the product seem to become, up to a certain point, as if the sun would draw out the oil also. Even the sun can become too hot, and so in midday it is best with cacao, especially at the start, to shade the produce. On the other

Question.—Do you find that sun-dried copra tends, on the whole, to arrive mouldy and dirty at the works?

Answer.—Sun-dried copra has a tendency to arrive mouldy and dirty at the works. This may be accounted for by the fact that fermentation can take place during the slow process of sun-drying.

Question.—Do you agree that the figures in attached reprint give a correct idea of the time required for drying by the various processes named, viz.:—

Method		Time
Sun	...	5 days
Grill (over bamboos)	...	10 to 12 hours
Hot-air chamber ...	...	3½ " 4 "
Rotary hot-air process	...	2 " 3 "

Answer.—We agree that the figures of the time required for drying, as quoted above, are quite possible figures, but there are many circumstances, such as country, climate, temperature, and system of mechanical drying which would affect results.

In a lecture delivered to a Missionary Industrial Conference at Kodaikanal, Sir F. A. Nicholson[1] told his audience of an experiment he made that could well be carried out on

hand, the process can be too slow, and hence cause with copra, as stated in Answer No. 2, fermentation to take place during the drying process. (See our book on "The Fermentation of Cacao," p. 151, and Preface. p. xxiii, for an explanation of this.)

[1] *Indian Agriculturist*, October, 1910.

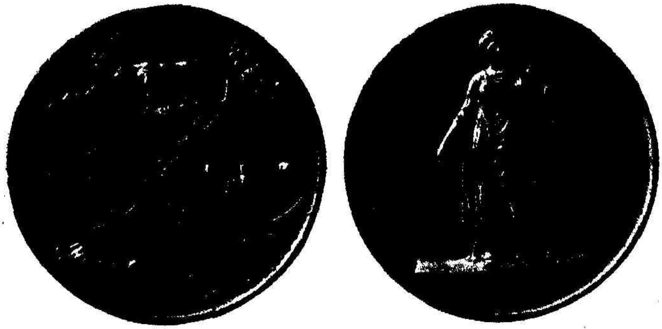
many estates, as by so doing much room would be made use of that at present is wasted, whilst possibly the crops would benefit from the protection of the palms as windbreaks, &c., and it is well known that coco-nuts when so planted yield profusely, on account of the room the leaves have on two sides, if not all round. Seven miles of coco-nuts, planting even 30 or 40 ft. apart, means 1,232 or 924 trees, which, at only 50 nuts a tree (a fair yield on an estate planted 30 by 30, and when planted singly a higher yield could reasonably be expected) would mean from 45,000 to 60,000 nuts a year. The lecturer explained that he started planting with coco-nuts a road that had been left shadeless for generations. The ryots derided the idea until the first half mile was planted, then they begged to be allowed to continue the work if they might take the profits. The planting was carried on for seven miles, and now yields a revenue that pays for the upkeep of 20 miles of road, besides benefiting both man and beast using the road, as well as protecting possibly the adjacent crops, and yielding foodstuffs, in this case used for local consumption.

Regarding the vexed question of coco-nut returns, several coco-nut propositions have been floated on this side, and it is claimed that these are but signs of a "boom" of this article, on the same lines as the rubber boom, only in a much smaller way. As was the case with

some of the principal rubber companies put upon the market, we have had several of these coco-nut propositions submitted to us by intending sellers anxious to know how the public are likely to receive such offers, or to what group of financiers it would be best to apply. Some of the offers were simply outrageous, such as 200 palms and even more to the acre, and annual yields of 200 nuts and over per tree. Such returns are useless, although it seems difficult to persuade the sellers to believe so. A company recently floated published in their report the following particulars, which, being fair average returns, we quote here as a guide for readers when coming over to sell their coco-nut estates. Fifty (strictly speaking, forty-eight) trees, planted 30 by 30, are calculated to the acre, and no well-planted estate, for reasons explained elsewhere, will place them closer than than this, since, as stated on page 61, a full-grown leaf can measure from 15 to 18 ft. The basis of the valuation of the estate was made on the average annual product of 50 nuts per tree of nine years old and upwards, and 40 nuts from palms of eight years. This, whilst a fair return, is the full average allowance, although of course many trees do exceed this number, Returns of 200 to 400 nuts per tree in a year are as rare as yields of 10 to 20 lb. of dry rubber per tree. Such returns may be obtainable, but should not figure in a prospectus.

COCO-NUT PLANTING IN THE WEST INDIES.

WHEN we were in the West Indies in 1890-91, and again in 1895-8, the coco-nut industry, taken as a whole, was a very minor one, but since then more attention has been given to the self-planted lands as well as the planted areas. The industry was represented in Trinidad mainly by the Nariva, Mayaro and Cocorite Cocales, with a few estates just forming. These cocales were formed by self-



Mr. Hamel Smith, senr., was awarded five medals as above (two gold, one silver, and two bronze) by the Society of Arts and Sciences, Trinidad (W.I.), 1876, when he had charge of the Nariva Cocal in that island. All the medals were the same size, and measure 2¼ in. across. The gold medal (in the possession of Mr. H. H. S.) weighs 5¾ oz.

planted shipwrecked nuts thrown up from the sea, and had grown up badly planted, with the palms often packed close together, and consequently yielding very poorly in comparison to the number of trees. Since then, however, plantations formed some twenty years ago and afterwards have come into bearing, so that the exports of coco-nuts from Trinidad have increased as follows :—

		Coco-nuts		Copra bags
1888	...	10,151,228	...	—
1898	...	12,430,016	...	—
1908	...	16,622,708	...	18,220
1909	...	19,158,513	...	15,247
1910	...	19,768,223	...	12,494
1911	...	20,466,209	...	10,315

Of course the large Indian population in Trinidad and British Guiana (probably 200,000 souls between them) has caused a large local demand to spring up for the oil, but, on the other hand, even with prices ranging from 93 cents to $1.10 per gallon, the close proximity of New York has raised the f.o.b. value of husked nuts from $24 to $32 per 1,000 so that it pays the planter better to ship the nuts, instead of making copra or oil. The increased attention given to the "cult of the coco-nut" of late has caused that excellent institution, the Imperial Department of Agriculture, to issue several bulletins and reports on the cultivation and diseases of the palms, all of which are well worth studying. Among

those we have on our book-shelves are :—
"Bud-rot Disease," *West Indian Bulletin*, vol. vi, p. 307; "Fungus on Coco-nuts" (by Stockdale), *West Indian Bulletin*, vol. ix, p. 361; "Coco-nut Diseases," *Agricultural News*, vol. ix, p. 254; whilst the latest one to arrive, having come to hand after the first proofs of this book were out, is the sixpenny booklet on "Coco-nut Cultivation," No. 70, running into 46 pages, with seventeen or eighteen illustrations, from which we take some of the following notes, leaving those wishing for fuller particulars to turn to the original.[1]

There are many situations in the Islands of the Lesser Antilles where the coco-nut palm can be grown to advantage. There are to be found open, low-lying, coastal lands possessing a light, porous soil and a moderate but sufficient rainfall. These centres can be turned into prosperous estates, within easy reach of cheap freights to all parts of the world, secured, be it remembered, without heavy land transport. It must be borne in mind, however, that for any estate to pay it must receive adequate care and attention, particularly as regards manuring and tillage.

One advantage the prospective planter in the West Indies would enjoy is that in choosing one of these coast localities he is not forced to pay high values for lands suitable for

[1] See also Appendix attached.

other crops, nor will he be displacing other cultivations. The land available is often only good for coco-nuts, and so can be valued accordingly ; at the same time there are plenty of rich alluvial lands to be met with close to the sea, on which coco-nuts might reasonably be expected to yield higher profits than any other crop.

The palms, we are told, thrive best where the mean temperature is from 75° to 85° F., and the mean annual rainfall is not below 50 in. It can, however, prosper in drier situations, provided there is a steady flow of water through the soil, such as is occasioned by the drainage of fresh water finding its way to the sea, and by the ebb and flow of the tide. The palms, however, are quite unable to tolerate the presence of stagnant water round their roots, and must also have ample sunlight. As the tree does not do well on steep slopes or in too shaded or sheltered situations, it thrives best on the lowlands round the coast, where the winds would cause cacao, rubber, &c., to prove unsuccessful. Provided the position is open and well drained the best soil is an alluvial loam, such as is formed on the banks of rivers that overflow from time to time. Light, deep, sandy loams, overlying corals, or any porous substratum, are also suitable, but it must be remembered that the plant depends very greatly on the fertility of the soil, and requires a good supply of humus ;

consequently, although it will grow it will not prosper on pure sand alone, unless quantities of manure and humus are supplied. To show the necessity of giving the plants plenty of room, since it is agreed that the leaves should not rub together, one has only to state that a full-grown leaf will measure from 15 ft. to nearly 18 ft. long, and from 4 ft. to 7 ft. wide.

The West Indian booklet (No. 70) gives (p. 4) the following notes on the root system that should be carefully noted, since the roots play so important a part in the matter of yield, especially when applying manure, more so even than those of the cacao and rubber tree do, important as they undoubtedly are. "The roots of the coco-nut palm arise in very large numbers from the portion of the stem below ground and spread out laterally in all directions, while, as in all monocotyledons, there is no tap root. The roots are red in colour, about as thick as a man's finger near their origin, and may attain a length of as much as 50 ft. Around the trunk of the tree they form an almost compact mass some few feet thick, while further out they become separated from one another. Some of them penetrate for a considerable depth into the soil, but the majority occur within a foot or two of the surface, and the plant must consequently be regarded as a surface-feeder. The young active ends of the primary roots, and the young portions of the secondary roots arising

from them, are both found at some distance from the trees. This is a point to be borne in mind when considering the application of manures."

Mr. William S. Lyon, writing in 1903, in his *Bulletin* No. 8, on "The Coco-nut in the Philippines," said, "Its subterranean parts are simply a mat-like expanse of thick, fleshy, worm-like growths, devoid of any feeders other than those provided at the extreme tips of the relatively few roots.[1] These roots are fleshy, not fibrous, and cannot thrive in any soil through which they may not grow freely in search of sustenance. It thus becomes obvious that stiff, tenacious, or waxy soils, however rich, are wholly unsuitable. All very heavy lands, or those that break up into solid, impervious lumps, and lastly any land underlaid near the surface with bed-rocks, or impervious clays and conglomerates, are naturally excluded. All other soils, susceptible of proper drainage, may be considered appropriate to the growth of the palm."

In the West Indies, as elsewhere, the greatest care must be taken in selecting seed, so that a strong uniform growth is obtained. Nuts for planting, we are told, should be obtained from carefully selected trees, which should be healthy and vigorous, about twenty-

[1]Which, our manuring friends must remember, we have just said may run out as far as 50 ft., and the manure in theory should be introduced at the extremities.

five years old, and known to produce a good crop of medium-sized nuts of good quality. As we advise our readers elsewhere, the West Indian experts also urge that "the trees from which the seed-nuts are taken should, as far as possible, be growing in a district whose general conditions of soil and climate are similar to those of the district to be planted." When the trees have been selected, the nuts also must be carefully picked over and chosen. They should be of medium size, not elongated, with a thin husk and thick kernel. The thickness of the husk may be tested by inserting a knife until it reaches the shell. Large nuts often have a very thick husk and a thin kernel, which is not desirable, while a small crop of large nuts is not as remunerative as a large crop of medium-sized nuts. The seed-nuts must have ripened on the tree, and be exactly ripe. The degree of ripeness can be tested by shaking. If it is unripe, and consequently still full of liquid, it will only give a dull, heavy sound ; when ripe and only about two-thirds full, it gives a sharp, clear sound which is easily distinguished from the first after a little practice. Nuts that are to be used for seed should not be thrown down from the tree, but should be carefully lowered, and care should be exercised not to damage them, in any way. In some cases the nuts, even when ripe, contain a large quantity of water, and it is necessary to allow them to dry in the

shade for a few days before planting. This drying must not be permitted in the full sun, as the kernel may then become partly cooked, and the germinating power lessened.

The nursery also does best if partly shaded. Here the soil should be well forked to a depth of about 18 in., thoroughly pulverized, and all large stones and roots removed. The seed-beds should be 3 to 4 ft. apart; and down the centre of each should run a trench 6 in. deep, in which the nuts are to be placed 12 in. apart, either dead horizontally, or with the *pointed end* somewhat raised. They should not be planted in a vertical position. After the nuts are placed in position, the soil removed from the trench can be utilized to cover the nuts with until "only about a quarter of the upper part of each projects. The whole bed must then be covered to a depth of 6 in. with straw, grass, or cane-brash, and the nuts should be watered from time to time if the weather is dry."[1]

It is recommended to plant 50 per cent. more nuts than are actually needed, to make up for those that miss, and since germination lasts on an average three to four months, those that do not show signs of life after that

[1] This, of course, is in the West Indies. It is doubtful whether on a very large estate the nurseries could be covered with brash in the way described, unless it were done with fibre-waste or dust as is done in gardens in England and elsewhere.

period, or which are of sickly growth, had better be burnt, or otherwise rendered harmless, for if left about they may prove dangerous as insect and pest breeders, having lain about for so long. The trees, according to the richness of the soil, should be planted 30 ft., and even 35 ft. apart (forty-eight and thirty-five to the acre), and the trees are best planted in triangles, or quincunx, the holes being 3 ft. cube. Again, we are told to leave them open for a time, and after the plants have been put in, the soil taken from the hole should be mixed with well rotted manure, leaf mould, &c., and the hole filled in with this mixture to a depth of 18 in. In Nevis fine megass (sugar cane fibre waste) is placed in the hole, and as the plan is reported to have proved successful, we do not see why coir-waste, when available, should not be used with advantage.

When the trees grow up, all join in recommending that a circle of 6 ft. to 8 ft. in diameter around the tree be kept free of weeds, and this circle, we are told, must be increased as the tree increases in size. Above all, at any age, whether seed-nut, seedling, or adult tree, planters must keep the soil well drained; let as much water as will pass over or through the land, but see that none remains, especially in the half-filled holes containing the seedlings. On account of the possibility of this happening some condemn this "pit" system of planting as just described, but there should be no need

of this. Once stagnant water is observed it must be drained away, and always kept on the move. The London constable with his "move on," would be a good illustrated motto to hang up in the bungalow of every coco-nut estate owner and manager, so far as soil water is concerned.

Cover crops recommended in the West Indies include *Crotalaria striata*, *Phaseolus mungo* (woolly pyrol), *P. lunatus* (lima bean), *Ricinus communis* (castor-oil plant), *Arachis hypogæa* (ground nuts), *Canavalia gladiata* (sword bean), *C. ensiformis* (horse bean), and possibly *Tephrosia purpurea* and *T. candida*, as well as sorghum or broom corn (*Andropogon sorghum*). Fuller details of this and other matters along the same lines will be found in the booklet, No. 70, referred to, and also in the Barbados *Agricultural News*, vol. ix, pp. 37, 341; vol. x, pp. 91, 245; Annual Report of Botanic Station, Antigua, for 1909, p. 22, and of Dominica, p. 38. As regards yield planters are advised here as well as elsewhere, when adequate white, or reliable native supervision is available, to allow the men and boys to climb the trees and pick the nuts, not to let them drop, but if unripe nuts, as from small proprietors' lands, are constantly being received for copra, it is best to allow the nuts to drop, so as to ensure perfect ripeness; in some centres it is urged (if the law does not actually exist) that

the producers be compelled to allow the nuts to drop, as unripe kernels cause such unsatisfactory copra, and one man's unripe supplies can give an entire centre a bad name. As the nuts need only be gathered two or three times a year, the cost of hand gathering would not come heavy, and any nuts that may be overlooked will, in due course, find their way unaided to the ground. On the other hand, Mr. William S. Lyon writes: "The practice, so general in the Seychelles, of allowing the nut to hang till it falls to the ground is certainly undesirable in these islands (the Philippines). On the contrary, the over-ripe nuts will seldom fall until dislodged by a storm, and it is no uncommon thing where the harvesting is left to natural causes to see nuts upon the trees that have sprouted and started to grow. Such nuts are, of course, worse than valueless for the manufacture of oil or copra, as there is a danger of their being included with the sound nuts, and even the husk has depreciated in value, the finest coir being, as a matter of fact, derived from nuts that have not attained full ripeness. In any case the nuts should be picked, and the crop worked up before any considerable enlargement or swelling of the embryo occurs, as from this time onward, physiological changes arise which injuriously affect the quantity and quality of what is called the meat. The heaping up of the nuts for some time after harvesting favours

some milk absorption, which seems to facilitate the subsequent easy extraction of the endosperm."

As regards the bearing age, and average or individual yields in the West Indies, we are told that "the tree may begin to produce nuts as early as the end of the fourth year; usually, however, they do not do so until the sixth or eighth year; whilst no crop of any great importance can generally be expected before the ninth to the twelfth year after planting. The length of this period depends very largely on the treatment which the trees receive whilst young, as well as on the fertility of the soil and the available supply of moisture. Subsequently the crop increases steadily, until the twentieth or twenty-fifth year, when it reaches a maximum, and continues more or less the same until the tree is from fifty to seventy years old. After that age the number of nuts produced by a coco-nut palm gradually diminishes, though crops of some size are borne until the tree is eighty or one hundred years old. In Ceylon, palms older than this even have been known to give useful yields. Five or six separate fruit-bearing flower branches usually occur on a palm at one time, and each may carry as many as ten nuts."

The question of manuring, pests and disease, &c., in the West Indies will be found in the sections devoted to those subjects, but all the experts are emphatic in their statements regard-

ing the necessity of adequate manuring and tillage if the estates are expected to do their best.

As regards returns in the West Indies we noticed that in the *Bulletin of the Trinidad Agricultural Society* for December, 1911 (vol. x, No. 69), the following queries are asked and answered :—

"(1) *Q.* How many nuts would it take to make a ton of copra (in Trinidad or Tobago)?

A. 6,000 to 7,000.

"(2) *Q.* What is the approximate cost of making a ton of copra?

A. $4.50 = 18s. 9d.

"(3) *Q.* What is the usual loss in weight in shipments of copra from Trinidad to European markets?

A. 2 to 3½ per cent.[1]

"(4) *Q.* How many gallons of oil should be got from a ton of copra?

A. 153 gallons with 63 per cent. extraction.

"(5) *Q.* How many gallons of oil should be got from 1,000 nuts?

A. 20 to 22 gallons, but much depends on size and quality of nuts."

These questions and answers are extremely useful, and should be noted. No. 5 and No. 1

[1] This seems to us too low. Shippers should reckon on 5 per cent. loss, we should imagine, especially if selling on a c.i.f. basis.

hardly tally, for if 6,000 nuts, which we are told in answer No. 1, give 1 ton of copra, they would also give 153 gallons of oil by answer No. 4, or 25½ gallons per 1,000 nuts, not 20 to 22 gallons as by answer No. 5. Even at 7,000 nuts to the ton of copra, at 153 gallons to the ton we should get practically 22 gallons of oil per 1,000, not 20 to 22 as suggested in answer No. 5.

This question of what number of nuts go to a picul or ton of copra or a gallon of oil is a vexed one. Differences of opinion are shown by the following table made up from various reliable sources:—

The sign = means "yield":—

1 gallon of oil weighs 9 lb. 4 oz.

40 full-grown nuts = 1 gallon of oil.

12½ gallons oil, or 500 nuts = 1 cwt. oil.

250 gallons oil, or 10,000 nuts = 1 ton oil.

170 to 200 nuts = 1 cwt. copra.

3,700 nuts = 1 ton copra.[1]

3 nuts = 1 lb. desiccated coco-nut.

45 lb. copra = 3 gallons oil, or 61·8 per cent.

[1] This it is claimed by the large soap manufacturers must be incorrect; they say at least 5,000 nuts go to a ton of copra, as is shown by its taking 3 nuts = 1 lb. desiccated coco-nut. (*See* also notes on Samoa, p. 135.) The difference in loss of weight between copra and desiccated coco-nut is far too small for it to be necessary to use only 3,700 nuts in the one case and 2,240 × 3 = 6,720 nuts in the other. Anyone can, however, soon check and see for himself how many nuts go to 1 lb. of well dried meat.

of total weight when extracted by "chekku" (native) mill (see illustration p. 416), and not by hydraulic press. Under hydraulic pressure perfectly clean, ripe nuts should give 66 per cent. oil and 34 per cent. poonac—at least, that is, in theory. In practice it works out at 62·5 and 37·5 per cent. only.

1 ton copra = 153 to 156 gallons oil.
40 coco-nuts = 6 lb. coir.
3 large nuts = 1 lb. coir.

On page 190 of this *Bulletin* we are told that with 2,000 acres or over in full bearing, (some say at least 5,000 acres), the crops will be sufficient to feed an oil-mill, and in connection therewith a coir factory might be erected for the manufacture of rope from the fibre.

Before leaving the West Indies, we would like to say a few words about Cuba, which at one time must have owned a very large number of coco-nut palms. "For more than thirty years," says Johnston as the opening words of his book on bud-rot, "the people of Cuba have discussed the cause of the gradual dying off of their coco-nut trees and have attempted to overcome it without success." According to Dr. Erwin Smith, writing in 1904, if the bud-rot disease continues to spread during the next ten or fifteen years as it has done during the past ten years, it will inevitably destroy the coco-nut industry of the island. But many parts of Cuba are eminently suitable for coco-nut culture so far as soil and climate are

concerned. There is no reason, therefore, apart from the careless habits of the planters who allowed in the past a valuable and widespread industry to be so curtailed, why Cuba should not again take a leading position as a producer of coco-nuts. Other centres have had bad attacks and suffered very serious losses from the bud-rot disease, but are taking various steps to drive it back, so without even mentioning their names, we will only say that no one would think of condemning them as coconut producing centres because of this trouble. Cuba, therefore, under the wing, and especially the scientific wing, of America, will, it is to be hoped, re-establish her reputation as a coco-nut producer, and not give way to despair, or, worse still, to indifference over the matter.

On the contrary, this island will, no doubt, be able to hold her own as a coco-nut producing centre, and more than her own when capital is turned towards her. Great possibilities are certainly there if made proper use of, and care taken to keep the coco-nut bud disease under. If the Cubans wish to make money, they must, the same as others, work for it, not spasmodically, but steadily and continuously. At present, the *Cuba Review* tells us, the only region where coco-nuts are now grown for export is at Baracoa, where, in spite of bud disease, some $135,000 worth of nuts were exported last year (1910). Meanwhile the Commission appointed by President Gomez

to examine and report on the disease started work a few weeks ago. "Since the disease in the Philippines appears to attack only the 'heart' of the crown," writes O. W. Barrett, "the symptoms are very readily noticeable in the dying or yellowing of the leaves and the dropping of the fruits. As soon as these symptoms can be recognized as coming from this particular disease the planter should lose no time in felling the tree and in destroying the bud and leaves thereof." If buried, at least 18 in., and better still 24 in., of good soil, not leaves and rubbish, should cover the foliage, and great care must be taken not to drag the diseased portions along the ground. The only means of combating the disease is to check its spread, and with attention this can be done before its germs can mature and be transmitted to the surrounding trees. We hope to hear, therefore, that Cuba has accepted the advice offered them, and by vigorously fighting the disease, re-established the industry once more in their midst.

COCO-NUTS IN MAURITIUS.

M. P. Boname, Director of the Station Agronomique in Mauritius, published in 1909, as *Bulletin* No. 19, an excellent report on coco-nuts and their cultivation. The report is in French and entitled "Notes sur la Composition du Cocotier." Here he shows that, taken as a whole, Mauritius is not greatly interested in

coco-nuts, but in St. Jean de Nove or Farquhar Island, and in some of the other islets off her coasts, the coco-nut is almost the only industry, and based on the samples of nuts, and specimens of soil received, M. Boname has drawn up the report referred to, running into some thirty-five pages, a large proportion of which is made up of analytical tables. These will be found very useful, but, unfortunately, we cannot include them here. Possibly, however, anyone interested in Mauritius would find excellent opportunities for establishing coco-nut cultivations at many centres. Before anything is done, it would be as well to communicate with the amiable Director of the Station Agronomique at Réduit, Mauritius. According to M. Boname's figures (p. 15) the kernel of the nut when fit for copra making, weighs, say, 251 grm. (roughly ½ lb.) and should then give 171 grm. of sun-dried copra, or 68 per cent. This means the loss of only 32 per cent. of water or one third of its weight. With an average weight of 171 grm. of copra per nut, an extraction of 52 per cent. of oil would yield 92 grm. of that article, therefore it is estimated that it would roughly take ten nuts to make a litre of oil (= 1¾ pints or ·220 gall.[1]) Since on page 8 we are told the average yield of eighteen samples of copra worked out at 64·87 per cent. oil, 52 per cent. as mentioned above is a low estimate.

[1] A litre of distilled water = 1 kilo.

COCO-NUT PLANTING IN PAPUA (BRITISH NEW GUINEA).

MR. STANIFORTH SMITH, formerly Administrator of Papua or British New Guinea, whom we had the pleasure of hearing lecture before the Royal Geographical Society, issued in 1909 a second edition of his Handbook of the Territory of Papua[1] in which he gave much useful information on the possibilities of the British portion of this Island for growing rubber, tobacco, cacao, coco-nuts, &c. The information *re* recruiting labour, labour ordinances, labour licences, land laws, estate management, &c., occupies a substantial portion of the book, and is worth careful consideration and comparison even by those engaged in planting outside Papua. The following notes are chiefly, in fact mainly, taken from this book, but they by no means exhaust all the information given.

The native population is unknown, but is estimated at between 400,000 and 500,000. There is an Immigration Restriction Ordinance which tends to discourage outside labour, but at the same time the local supply seems

[1] Price 1s. 6d. J. Kemp, Government Printer, Melbourne, Australia, or at the Offices of the Australian Commonwealth, 72, Victoria Street, London, S.W.

adequate and, so far, reasonable as to cost. Those, therefore, engaged in industrial pursuits, possess an advantage in being able to draw their labour supply from the Territory, thus obviating the heavy expense of importing coolie labour. The native is excellent at scrub clearing, and shows a considerable aptitude and intelligence in acquiring a knowledge of his duties, if explained by practical example; this is especially the case with plantation work.

During the year ending June 30, 1909, 4,226 natives were indentured, and apparently no difficulty was then being experienced in readily obtaining all the labour required. The maximum wage, including rations, was about 1s. per day in 1909. These indentured Papuans are considered by competent authorities to be quite equal to the Kanakas of the Melanesian Islands of the Pacific, who were, until recently, largely employed on the Queensland sugar plantations.

Coming to the matter of soil and rainfall, we are told that the latter is heavy and evenly distributed, with the exception of a strip of country extending along the south, about forty to fifty miles east and west of Port Moresby, the capital. As to the nuts themselves, a planter of many years' practical experience in Ceylon has carried out some careful experiments as to the relative value of coco-nuts from the Solomon Islands and Ceylon as compared with the indigenous nuts growing round

the villages in Papua. The average weight of dried copra per each hundred nuts was found to be considerably in favour of the local (Papuan) article. On March 31, 1909, the following area was returned as being under plantation cultivation:—

Coco-nuts[1]	5,365 acres.
Rubber	1,702 ,,
Sisal-hemp	382 ,,
Coffee	180 ,,
Other cultures	111 ,,
Total ...	7,740 ,,

The copra exported, however (value £7,515 in 1907-8, £7,467 in 1906-7, and £9,315 in 1905-6), as well as the nuts consumed locally, come entirely from the native lands, or at least did so until quite recently, there being an ordinance in existence compelling the natives to plant coco-nuts for their own use. An effort has been made to arrive at a rough approximation of the areas owned by the natives, as there are no means of accurately estimating the total. Based on careful calculations made by those capable of forming an opinion, it is surmised that the British section of the Island owns some 35,000,000 trees, planted on 350,000 acres at 100 to the acre.

[1] Those believing as we do in mixed estates will find handy particulars in Mr. Staniforth Smith's Handbook of the cost of planting all these products, as well as tobacco.

The output of the Island, therefore, can be easily estimated.

To show the chief divisions at present producing coco-nuts, we will give the table, for although this by no means proves that the smallest producing division is the least suitable (it may only have been the most neglected) it does show where the most land is already occupied. The estimate is made up as follows:—

Western Division	... ...	85,000 acres.
Gulf ...	... ...	45,000 ,,
Central	... ...	25,000 ,,
Eastern	... ...	150,000 ,,
South-Eastern Division	...	25,000 ,,
North-Eastern ,,	...	12,000 ,,
Northern ,,	...	8,000 ,,
	Total ...	350,000 ,,

A representative collection of samples of soil was obtained from various districts throughout the Territory, where agricultural settlement had taken place, or was likely to do so. Each sample, it is believed, represented a fair average of the agricultural soil of the district. These were subjected to mechanical and chemical analyses by the agricultural chemist attached to the Department of Agriculture, New South Wales, who reported as follows:—

"Speaking generally, these are rich, fertile soils of a loamy nature, friable, and fairly easy to work. They are good nitrifying soils, and

should be capable, under cultivation, of giving good results with any kind of crop suitable to the climate."

Regarding winds, Papua, being outside the hurricane belt, possesses a great advantage in this respect over those centres that do not escape this trouble. The methods of cultivation recommended are by way of a nursery and transplanting. The trees are said to start yielding at five years, and to bear heavily at eight and nine years old. Three thousand nuts are reckoned to make a half-ton of copra, and healthy trees will live at least sixty years, probably longer.

The following estimate is given of the cost of clearing and planting 500 acres with coconuts:—

1.	Felling and clearing, at £2 per acre (exclusive of supervision)	£1,000
2.	Lining and holing	150
3.	Cost of 30,000 coco-nuts for planting	120
4.	Planting, 27 × 27 ft. = (60 to the acre)	125
5.	Weeding and maintenance	200
6.	Roads and drains	100
7.	House for superintendent	100
8.	Huts for natives	40
9.	Tools	40
10.	Supervision	300
11.	Recruiting seventy natives and fees...	220
12.	Nurseries	20
13.	Medicine chest[1]	5
14.	Transport	80
15.	Rent of land	—

[1] See "Health in the Tropics" for stock recommended.

16.	Preparation and registration of lease	—
17.	Survey of land...	—
18.	Contingencies	£200

Expenditure at the end of the first year (equal to £5 8s. per acre)	£2,700
Upkeep for five years at £750	3,750
Total expenditure (we take it, exclusive of supervision) at end of sixth year, equal to £13 per acre	£6,450

A second estimate, besides the above, of the expenditure necessary to plant 500 acres of coco-nuts gave for the first year £2,856, or £5 13s. 3d. per acre, including the erection of houses for the manager and assistant manager. The total estimate of the cost of planting 1,000 acres, say 500 the first year, 300 the second, and 180 acres during the third year was worked out as follows :—

First year	£2,856
Second "	1,935
Third "	1,602
Fourth to eighth year	7,115
Total	£13,508
Or £13 10s. per acre.	

In the seventh year the trees should give forty nuts each, or 200 tons of copra. In the ninth year this should increase to sixty nuts per palm, or 300 tons of copra, as the total crop of the 500 acres.

The cost of upkeep might be partly defrayed by the returns from catch crops reducing the

capital outlay considerably; these crops can be chosen from among the following: maize, Liberian or better still robusta coffee, pepper, ramie, murva fibre, tapioca or cassava, citronella and lemon grass, tobacco, sarsaparilla, ipecacuanha, bananas, soya-beans, cayenne pepper, ground nuts, vanilla, coca, sweet potatoes, yams, Manila or sisal hemp,[1] ginger, arrowroot, cotton, &c.

For large plantations, where the capital available allows, ploughs drawn by traction engines have proved very successful for breaking up the soil, provided the same has been freed of logs and stumps, and the conditions are otherwise suitable. In one of the British South Sea Islands, a case is reported where a planter with a traction engine, costing £865, and five four-furrow, stump-jump Australian disc-ploughs, costing £210, has been able to plough twenty-five acres per day, in good weather, to a depth of 15 in., his best day amounting to thirty-five acres. Excellent work was done at a moderate cost. We will conclude this section with the following extract from an article published by the manager of one of the largest coco-nut plantations in Papua, which appeared in the *Tropical Agriculturist*, of Ceylon, for October, 1908:—

"The Territory is situated outside the

[1] Full estimates are given for planting sisal hemp in the Handbook. The Philippines recommended Manila hemp in the same way.

hurricane zone, has an agreeable climate, and a plentiful rainfall, except in the dry belt of the central division.

"Thus the planter has every advantage which nature can bestow to render his enterprise successful. The soil is considered equal in richness to anything in the world; and our correspondent's experience leads him to express it as his opinion that, in the course of a few years, when Australia has realized what a valuable asset she possesses,[1] right at her very doors, Papua will have become the most prolific and richest exporter of tropical products outside of Ceylon. Labour is plentiful and cheap, and land easily obtainable on the most liberal terms."

[1] We think that after his lecture before the Royal Geographical Society this year, already referred to, both Australia and the Mother Country can now be said to have realized the economic value of Papua.

COCO-NUT PLANTING IN THE PHILIPPINES.[1]

Of all the coco-nut centres this is the one that we have heard the most about of late years, thanks to the Bureau of Agriculture at Manila, and to the writings of Barrett and Dean Worcester, Lyon, Copeland, and others.

Owing to the higher prices, and more general demand for coco-nut products, former pasture lands and waste places have been, or are now being, planted up with coco-nut palms in the Philippines, as has been the case in Malaya with rubber. Some of the estates, the Lapoc Plantation Company, at Sulu, for instance, have planted Ceará rubber with coco-nuts, or rather as there were 1,000 palms to 15,000 Ceará trees, one should say that the coco-nuts were planted with rubber. Some of the estates also report the planting of such catch-crops as ground nuts, tapioca, maize, &c.—but these are said not to pay, except on paper, though, be it noted, in some cases they

[1] There are five interesting illustrations of copra-drying in the Philippines, but these we have included in the section on Copra.

have the advantage of helping to keep a good supply of trained labour on the place.

This being so, those who find themselves placed in circumstances where their labour seems restless and discontented, might remember this, much as they may otherwise be prejudiced against catch crops.

Dean Worcester speaks very optimistically of coco-nuts in the Philippines. "After fifteen years of observation on the ground in the Philippines," he starts his pamphlet, "I have reached the conclusion that no branch of agriculture there offers such certainty of steady and assured returns for comparatively small investments as does the growing of coco-nuts, which may be raised to advantage as far north as Pangasinan, La Union, and South and North Ilocas, whilst they flourish in the Southern Philippines to a degree nowhere excelled and seldom equalled in other countries." This same authority speaks strongly of the slovenly, untidy, over-crowded state of the Philippine groves. As a rule, little effort is made, we are told, to keep the ground under the trees free from brush after the palms reach the producing age, and it is by no means unusual to find forest trees competing successfully with the palms for light and air. It is seldom that effective means are taken to check the depredations of fruit-bats, crows, and monkeys, or to disturb the rats which not infrequently nest at the base of the leaves and

help themselves to the fruit.[1] In spite of all these drawbacks, the Philippine exports in 1909, apart from its heavy local consumption, place the islands easily first of all centres as a producer of coco-nut products. During 1909 some 232,728,116 lb. of copra and 364,788 gallons of oil were exported. The output would be, however, very much larger if the estates were kept cleaner. Not only are the nuts lost in the bush and scrub left standing, but the accumulations of rubbish and decaying vegetation harbour beetles, especially the black borer (*Oryctes rhinoceros*). Leaving dead wood about also attracts white ants, which give much trouble where all the jungle has not yet been removed, or is allowed to come up again. Wild pigs also give much trouble, to such an extent at times that fencing has to be resorted to. Here again, however, with a clean estate, and the surrounding lands free of jungle, the nuisance can be abated and finally disposed of. Mr. O. W. Barrett gives very good advice to those thinking of planting coco-nuts in the Philippines, with regard to the compost heap, as did Dr. Alford Nicholls, of Dominica, in

[1] Talking of rats, to show how these animals swarm in agricultural centres, we would call the reader's attention to a report in the *Malay Mail* that fishermen in the dusk, seeing what they believed to be a shoal of fish, cast their nets and dragged them on board only to find them full of rats. They had apparently struck a migration of these rodents leaving one island for another in search of food.

his handbook, entitled "Tropical Agriculture," which has now become a classic among those interested in the industry.

If no secondary crop be planted between the coco-nuts, Barrett tells us, the disc-harrow is a very good implement for keeping down the weeds and grass. Shallow ploughing between the trees is in some cases advisable, but there is danger of injuring the roots of the palms; the ploughs, on that account, should never pass nearer than 1·5 metres, say 5 ft., to the base of the palms. It is questionable whether fallen leaves should ever be burnt, unless there is fear of fungus, or trenching and burying is too costly. It is best, according to Barrett, to collect the leaves as often as possible, at least three times a year, and, better still, every other month, and strip them, *i.e.*, cut the leaflets off the mid-ribs, burying the latter in a narrow trench between the palms, deep enough to avoid the beetles, which go down a good depth, from getting at them. The leaflets should be thrown on the compost heap, together with such husks as are not burnt, grass, straw, and other rubbish, with any dead animals or birds, and all left together to rot. These heaps should not be built-up on the bare ground, otherwise drainage takes place, and valuable plant foods are lost. They should be laid on concrete, or cement-covered bricks, with a roof to prevent the entrance of too much rain, which will wash out and waste that which one wishes to conserve. Those, how-

ever, who cannot put up a permanent roof, can erect a framework of bamboo and palm-leaves, which is all the better for not being absolutely rainproof, as allowing the water to drip through moistens the heap and so prevents the escape of ammonia and other useful plant-foods, whilst breaking the force of the heavy rains that would wash the ammonia out. In any case, during the dry season the heap must be watered to prevent the ammonia escaping, and should furthermore be covered with grass, leaves, &c., to keep in the moisture.

Extensive areas of unoccupied, unclaimed land suitable for coco-nuts exist in the Philippines, according to Dean Worcester. They are to be found in Mindoro, Mindanao, Palawan, and the small islands around. Some, being free of wild hogs and other pests, offer advantages over others. Drawbacks are encountered in the absence of fresh water and the extreme isolation. Still, no one must expect perfection, and it is for each to make his choice according to his temperament. Estimates based on actual work done in felling trees and clearing land vary from $5.60 to $16 per acre. One authority quotes as follows:—

Felling trees	$1.00	
Cutting and burning ...	4.00	
Stumping	8.00	
Ploughing	2.80	= $15.80

Mr. Y. H. Shipley, of the Mindanao Estates Company's plantation at Davao, claims that

one man can clear an acre in twenty days. This at $0.25 a day would make the cost work out at $5. Others again talk of $3.60 an acre. Estimates vary considerably, therefore, even by those who have paid for the work under discussion to be done for them.

It will be noticed how at all centres the leading authorities, when speaking of preparing the land for coco-nuts, urge the importance of adequate ploughing and cultivation. At least once a year, according to the Bureau of Agriculture in the Philippines, the land should be ploughed, even after the palms are planted, and on lands infested with cogon grass it may be necessary to do so twice. As already stated, the cultivation must not go too near the trees. If the ground near the trunks is inclined to crack during the dry weather, it must be raked over, not dug, as the spade or fork may damage the roots. Barrett prefers the disc-harrow to the plough when the soil between the palms needs being lightened. On a well-kept estate Worcester reckons that one man can look after 1,000 trees, that is, 20 to 25 acres.

San Pablo, claims A. E. Byars, Agricultural Inspector, is the largest and richest in agricultural products of all the towns in Laguna Province (P.I.), and is the centre of the coconut industry, from which the town derives its wealth. The nuts are not gathered at stated seasons, but every two or three months. The nuts are detached by means of a hooked

knife attached to a very long, slender bamboo, as is done in the West Indies with cacao, or a man climbs the palm and cuts the nuts off with a sharp knife. The following figures as to the cost of collecting the nuts, &c., were computed by Mr. Byars in 1908 from data collected by questioning dozens of coco-nut growers in Laguna and Tayabas Provinces :—

	Per 1,000 nuts.
Cutting down from trees ...	P[1] 1·00 to 1·20
Collecting into heaps	0·24
Husking	0·60 to 1·00
Halving	0·20
Drying and making copra ...	2·50
Grinding meat and making oil	1·00

A labourer is estimated to be able to cut down from 1,000 to 2,000 nuts a day, according to the height of the palms and the quantity of undergrowth on the ground. One man can husk 2,000 nuts a day, or rasp the meat from 1,000.[2]

The "Decennium Number" of the *Mindanao Herald*,[3] published in February, 1909, includes an estimate of the cost of planting

[1] P = Philipino = 2s.

[2] In Malaya, husking 500 nuts is estimated as a day's work. "One coolie ought to husk 500 nuts a day," we are told.

[3] The Decennium Number of the *Mindanao Herald*, to commemorate ten years' American occupation of the Philippine Isles. Published at Zamboanga, Mindanao, Philippine Isles.

2,500 acres of land in hemp and coco-nuts, drawn up at the request of the editor by one of the oldest and most successful members of the Davao Planters' Asociation, whose secretary, Mr. Max McCollough, has at times favoured us with his interesting experiences of Philippine agricultural industries.[1]

We reproduce some particulars of these estimates, so far as the coco-nuts alone are concerned, because in spite of the attraction of rubber, cacao, sea-island cotton, &c., in the Philippines and elsewhere, the "Cult of the Coco-nut," if carried on with system and forethought, is capable of proving as reliable and safe an investment as the other crops named, and whilst so many have advocated, and are still actively pushing, these other industries, we hear few advocating coco-nut planting.

Coming now to the figures contributed by the planters in the Philippines, we learn as follows :—

[1] See, for instance, Mr. McCollough's illustrated article on "Manila Hemp," in *Tropical Life*, June, July and August issues, 1909. Another authority (E. B. Copeland, *Phil. Journ. of Science*, p. 22, January, 1906) does not, apparently, recommend the planting of hemp if it can be avoided, for he says: "It is a very common practice in Mindanao to plant coco-nuts and abacá (Manila hemp or *Musa textilis*) together in the expectation that the abacá will support the commercial undertaking until the coco-nuts mature . . . . but the maturing of the former is delayed by probably two years, and the trees are never as robust as those which were better illuminated from the start."

	Dols. (4s. 2d.)
Cost of 1,024 hectares Government land at $5 (gold)	5,120.00
Survey, preliminary and official expenses ...	400.00
Clearing timber and planting 1,024 hectares with 122,880 coco-nuts, at 120 to the hectare (48 to acre or 30 ft. × 30 ft.), at $10 the hectare	10,240.00
122,880 seed coco-nuts at $20 per 1,000 ...	2,457.60
Clearing undergrowth from 1,024 hectares eight times during three years	7,680.00
Buildings and quarters	3,000.00
Fencing...	2,000.00
Cost of animals	600.00
Tools	500.00
Overseer's salary for five years, at $1,500 per annum	7,500.00
Manager's salary for five years, at $4,000 per annum	20,000.00
Cattle	2,200.00
Incidentals	1,000.00
	$62,697.60

The only objection one may have to make to the above is on the cost of the seed-nuts. If 123,000 are to be planted as shown above, 20 per cent. more[1] ought to be bought, or say 150,000 in all, making $3,000 cost of seed-nuts, instead of $2,457. The difference is not great, but is worth pointing out, because we like to be right in our estimates, and above all, we want to warn owners against unthinkingly buying only just as many nuts as they mean to plant. Again, $500 for tools, including ploughs, to plant 2,500 acres also seems too

[1] See p. 64, where 50 per cent. even is recommended.

low; at least $1,200 should be allocated for this. If not needed, it will not hurt; better have too much than too little; taken, however, as a basis to work on, and especially as showing a list of what is wanted on a large coco-nut estate, the table is extremely valuable. We would urge prospective planters again not to economize in fencing, if at all necessary; otherwise the animals can do a great deal of damage, worse still, can throw the estate back two or three years on account of a successful raid upon its seedlings for fodder. It is not only what they eat, it is what they nibble at, trample upon, break down and generally destroy. Once, of course, the trees have run up there is no need to trouble about fences; for rats, and occasionally squirrels, monkeys, and in some cases land-crabs going down to the sea to spawn, and such fry, can alone give trouble, and no fence can keep these out, at least no fence that it will pay to erect. With regard to the utilization of cattle, with which we deal at some length in the section "Cattle and Catch Crops," and in the Panama and Mexican sections, as no expense is incurred in feeding them, grazing territory and a fenced-in corral at night[1] being all that is necessary, this matter is worthy of the attention of the wise planter where, in conjunction with the poonac, there is grass or other green cover crops suitable for

[1] See Decennium Number, p. 59.

feeding, growing under the palms. If the palms are wide planted (30 x 30) and the soil anything else but the sand, pure and simple, along the sea-shore, pasturage is sure to spring up, and care will only be necessary to eradicate harmful growth and encourage that which is good both for the cattle and the palms.

The whole article by the Davao planter emphasizes the advantages of irrigating and adequately cultivating coco-nut lands, as we have always claimed for such methods. Although few, if any, of our readers outside the Philippines will care to plant Manila hemp (*Musa textilis*) under the coco-nuts, as is advocated for those islands, other crops, as sisal in East Africa,[1] cotton, &c., as we explain in other sections, can be grown in some places, for several years with advantage and profit. Irrigation properly carried out would then be as beneficial to the secondary crop as to the coconut palms, and to the copra that they yield. "All American planters in Davao," we are told, "now agree that irrigation and cultivation are necessary and an excellent investment, as they increase the amount of fibre and bring the hemp to quicker maturity. Irrigation, if properly managed, provides an even condition of moisture, thus keeping the plants growing all the time, whereas a month or two without rain or irrigation will cause them to remain stationary."

[1] See *Tropical Life* for April and May, 1912, *re* "Alcohol from Sisal Refuse."

If our Philippine friends are believers in irrigation, so they are in the value of manuring. When speaking of raising coco-nuts alone, *i.e.*, without a secondary crop, we are advised to turn cattle into the groves as soon as the trees are two-and-a-half years old. Their presence keeps down vegetation and fertilizes the soil, and at two-and-a-half years the cattle cannot injure the plants. Doing this has caused the palms at Zamboanga to bear at from one to one-and-a-half years earlier than when left alone. Fertilizing the soil of an old grove almost doubled the size of the trees. Coco-nut trees in the Moro Province of Mindanao will produce their first fruit in from five to five-and-a-half years, and will yield commercial produce six months later. In another twelve months—*i.e.*, eighteen months after yielding their first fruit—they will reach their full-bearing stage. As already stated, we go more fully into this matter elsewhere.

Going back to the estimate, this can be further dissected, and the expenses allocated to each year, say for the first three years. Out of the $62,700 shown to be needed as total expenditure, $50,000 only will apparently be needed for the first three years, as follows (what have been left out are, of course, the remaining two years' salary, and a proportion of the clearing and weeding; in any case the Philippine authority draws up his annual budget of expenditure as now shown):—

FUNDS REQUIRED FIRST YEAR.

	Dols.
Cost of land	5,120.00
Survey	400.00
Clearing, $\frac{1}{8}$ area to plant	3,400.00
Seed-nuts	820.00
Cleaning, $\frac{1}{8}$ area to plant	1,000.00
Building and quarters...	3,000.00
Fencing	1,000.00
Animals...	600.00
Tools	500.00
Salaries, manager's and overseers'	5,500.00
Incidentals	500.00
Total for first year	21,840.00
,, second year	16,000.00
,, third year	12,080.00
Say, in round figures for 3 years	$50,000.00

In the Philippines it is reckoned that further funds required in excess of the above amounts for bringing the estate to production stage should be available out of profits from the store and cattle. The above includes, we are told, the purchase of cattle for beef purposes, say 100 cows, with the necessary bulls, valued at $2,300; but if this is so, their cost, and that of stocking the store, are not shown, and the most primitive little wayside box eats up £100 or $500 of goods, including freight and charges, in no time. It seems therefore that we must add another $3,000, at least, to the first year's estimate, even if it can be cut away on the second and third year. No one can make a profit out of a store without first stocking it,

so this should be allowed for at the very beginning. Given people who can be influenced to buy from the store, such as the surveyors, axemen, and bush-clearers, the owner can immediately make arrangements for trading, and for this reason the store is the first building to erect, and to spend money on for stocking. Well assorted stores can certainly do a good trade, even without the help of a heavy liquor traffic; which, whatever profits it may bring along, is often productive of serious troubles and upsets. The less freely liquors are sold, anyway at the start, the fewer "sprees" will be run, and the faster will be the progress made in clearing and planting. With regard to the best plough for cogon or lalang grass, one of the English "Jumbo" type would probably be most useful, as this will cut off the grass a good way down, leaving it on the top to die off and fertilize the soil, at the same time acting as a mulch; or the grass could be collected together by means of a cultivator and burnt. Such ploughs, however, cost about £5 to £7 each, at least in England, and then have to be packed and sent out, and it is no use buying cheap makes; to do so is a bad policy at any time, but when eradicating a strong, tough grass, a strong cutting plough is an absolute necessity. At this rate to spend £100 or $500 for ploughs alone would not be excessive for properly cleaning and cultivating 2,500 acres, especially when grass has to be

eradicated. By the time these ploughs are *hors de combat* the plantation would probably be fairly well ship-shape, and although we may be firm believers in cultivation between the palms, everyone is not, so that, at any rate as far as this section—which is concerned only with the initial outlay necessary to start the estate—is concerned, we will only suggest that $500 be allocated as necessary for the purchase of ploughs to eradicate grass and cultivate the land before finally planting out.

Regarding the question of ploughing *versus* non-ploughing, it will be noted throughout this book how unanimously the experts at the different centres urge the absolute necessity of sufficient tillage (*i.e.*, ploughing, general cultivation, and manuring) if good crops are to be looked for.

Unfortunately, we are not told the highest, lowest, or average yield, or how many nuts per tree are obtainable in extreme cases. This is what everyone is on the *qui vive* for, as yields seem to vary from twenty to 200 nuts per tree, with an average perhaps, taking the coco-nut world round, of forty nuts per tree. We are told, however, here as elsewhere, that there should not be more than forty-eight trees to the acre (30 ft. by 30 ft.), and then $1 (or 4s. 2d.) per tree per annum could be looked for as the *net* profit on freehold estates of good size. The one quoted had 122,880 trees. If the trees are planted closer than 30 ft. by 30 ft.

the production is reduced. Another fact that we have called attention to is mentioned, *viz.*, in order to obtain the maximum amount of nuts from each tree it has been found necessary to guard against the branches of some trees touching or overlapping those of the other trees. This prevents the free circulation of wind through the palms. The continual movement of the branches of the coco-palm is absolutely necessary to its normal functions.

What the writer of the Davao article considers to be a conservative estimate places the cost of cultivating the 2,500 acres at $33 (American) per acre. This includes cost of land, warehouses, men's quarters, animals, farm implements, tools, wire fence, hemp plants, salaries, wages, &c. Details of expenditure are given year by year. In them we note the following: Cost of land, $2 (8s. 4d.) an acre; cost of clearing and cultivating, $20 (83s. 4d.) an acre; cost of coco-nut plants, $20 per 1,000; 1,000 Manila hemp plants go to the hectare, or 400 to the acre; cost of caraboes, or water-buffalos, $30 each. At the end of the second year the 300,000 hemp plants, laid down at the start, are calculated to give 2 lb. fibre per stalk. Some give down to only 1¼ lb., but at 2 lb. we get 600,000 lb., or 436 piculs (picul = 133⅓ lb.), worth $11.50 per picul = $5,014; less cost of stripping, drying, baling, &c., $4.50 per picul, leaves $3,052 net profit. The third year these 300,000 plants are reckoned to give $25,081

gross profit. After that the returns are bulked with other items.

The question of the best distance at which the palms are to be planted seems agreed to as 30 ft. by 30 ft., or forty-eight to the acre, when the cost of the land does not prohibit this; although we have heard of planters starting at this distance, and then putting the trees closer to keep down weeds. If, as our Davao friend claims, the palms need space for their leaves to move about freely, then 30 ft. by 30 ft. is not too wide, only, of course, the weeds must be kept down. In case of disease breaking out, the wider distance has, of course, a distinct advantage; and when closer planting is resorted to, the cost per acre, though not necessarily per tree, for manuring, cultivation, &c., would be increased.

Mr. Barrett, in common with all leading experts of to-day, tells us to plant wide; and the manner in which he writes on this subject betokens that he would like the palms planted even wider than the spaces he gives, but is weaning the planters from their close distances by degrees. Unless, he urges, at least 8 metres (1 metre = 39·37 in.) or 26 ft. 3 in., is allowed between the rows, the yield is seriously affected, and it is believed that the yield of many plantations in the Philippine Isles is fully 50 per cent. below normal, due largely to excessive close planting, as on alluvial soil the space should be increased to 10 metres,

or just upon 33 ft. In the Philippines the quincunx system is commonly used, *i.e.*, each tree is set opposite the interspaces of the adjacent rows on either side of it; this allows each tree a little more room than does the square planting. The following plan is recommended as the best, especially for large plantations on level lands: Blocks of four trees are set 8 metres apart, and around this block extends a space 10 metres wide; in other words, the rows alternate 8 and 10 metres in each direction. This, it is claimed, induces a slight leaning of the tree, which facilitates climbing; it also leaves partially open a considerable space which may be planted with beans and other crops, especially during the first eight or ten years. In good alluvial soil a well-grown palm should begin to flower during its fourth or fifth year, but the average bearing age of the Philippine palms as a whole is probably not less than eight years, and in many cases twelve. The delay, however, seems avoidable, as it is due to the poisoning effects of cogon roots and lack of ventilation. No details are given of the annual crop of nuts per palm.

The Bureau of Insular Affairs (War Department), Philippine Isles, recently issued a pamphlet on "Coco-nut Growing in the Philippine Isles, with special reference to cost of production and profits from copra making," by Mr. Dean Worcester, which

pleased us very much. We hope it will have a good circulation, as any planter hesitating between planting coco-nuts or not on a large or a small scale, would certainly be induced to give them a trial after studying the simple but reliable instructions given by the author. The pamphlet runs into thirty-one pages, including nine pages devoted to giving detailed tables of cost of establishing a 2,500 acre plantation. Its interest is further increased by the inclusion of sixteen full-page photographs, showing the drying of the nuts, &c., some of which we have taken the liberty of reproducing in the section devoted to the preparation of copra.

We quite agree with this authority's remarks, reproduced on the second page of this section, not because the value of coco-nuts and coco-nut products to-day stands at a record level, but because we know ten, and even twenty years ago, when coco-nut planting had but few friends to speak up for it, owners of well-managed groves used to draw very fair profits therefrom in comparison to the few cents or dollars expended on the place during the course of twelve months. If coco-nuts even paid in those days small and large producers alike, it is well to think of what they will do with present prices and prospects. If you have good, deep, rich soil, plant cacao, rubber, or such crops; but if you have odd pieces of land, or areas of poor soils, do not let these run to waste, but plant coco-nut palms on them,

to the benefit of the soil and your own pocket. Again, as stated elsewhere, quite a respectable crop can be obtained from palms planted avenue-fashion, for protection from wind or sun, along the border of the lands planted with the main crop of the estate. Such palms will, as a rule, yield above the average on account of the room they have to expand on all sides, and their produce will at least help to pay the cost of the up-keep of the road. When planted alone, Mr. Worcester talks of 32 ft. apart, or forty trees only to the acre, but also tells us (speaking, of course, of the Philippines) that in general it may be said that where soil conditions are favourable for catch-crops, actual experience has shown that under good management they can be made to pay approximately the cost of the plantation up to the time the coco-nut trees fruit. We do not altogether gather this from the general remarks, since we are told just above this that "during the fourth, fifth, and sixth years, by the end of which time the trees will have begun to bear, it will be necessary to keep the soil clean, and there will be no returns from catch-crops." Are sufficient profits obtained during the first three years to pay the cost of keeping the land clean? This cost is estimated at $2 to $5 an acre per year = $6 to $15 for the three years. According to Mr. H. C. Lamb, Superintendent of the Iwahig Penal Colony, who seems to have had large experi-

ence in the matter, three catch-crops can be grown advantageously with coco-nuts. He recommends "first a crop of corn, and subsequently two crops of mountain rice."[1] According to Mr. Lamb, the first year's catch-crop should yield a profit which should go towards paying the cost of clearing the land, and the second and third years should yield sufficient at least to pay the cost of cultivating the land by covering the cost of keeping it clean and under cultivation, which must be done in order that the young trees may make their best growth.

The other day we were discussing with a friend the cost of importing good seed nuts into the Bahamas, and our estimates did not agree. Our estimate, however, was the more correct of the two, for we valued them at four cents or twopence each, landed at the estates in the Bahamas, and even in the Philippines. Mr. Worcester estimates the cost of good seed nuts at one and four cents each, with two and a half cents as a fair average cost.

We are glad to see the advantages, if not the necessity, of ploughing are emphasized. "I have seen," Mr. Worcester tells us, "the value of ploughing quite conclusively demonstrated

[1] Our West Indian friends, who up to now have not made the most of their splendid opportunities to organize and develop their coco-nut lands and output, should be able in many cases to plant these catch-crops, for which the local demand is important and increasing.

on a coco-nut plantation in Mindoro, where the trees are set out in straight lines and at proper distances. I noted that the ground had been ploughed between the trees on one side of the highway, while on the other side there had been no ploughing, but the grass had been kept very short by cattle grazing on it. The trees around which the ground had been ploughed looked decidedly more flourishing, and were bearing more heavily than were those palms where the ground had not been ploughed."

On the question of yields Mr. Worcester, in his pamphlet, goes to others for help as follows: "According to a (Philippine) Bureau of Agriculture bulletin, an acre of properly planted coco-nuts should produce about 2,000 nuts per year, or 50 nuts per tree. The same authority states that trees abound which by actual count average annually 50 nuts per palm; that at Sarabaya trees average 60 nuts per year over hundreds of acres, and that this condition will be found to prevail in Pangasinan, La Laguna, Cebu, Panay, Mindanao, and wherever trees are grown on a generous scale. It is further stated that perfectly authentic cases are reported of as many as 128 nuts being taken from a single tree in a year.

"One tree at Zamboanga, the owner claims, never produced less than 200 nuts annually during a period of twenty-three years. This

man claimed that his trees averaged him 100 nuts per year, sometimes falling to 60, and another time running as high as 130. Lieutenant Fortisch, Philippine Constabulary, reports that at Ginoog, in Misamis, coco-nuts do particularly well, and that a planter there claims 120 nuts per tree per year from old, well-established trees.

"Senor Vicente Diaz states that mature, bearing coco-nut trees will produce from 60 to 120 nuts per year, with an average of 80; whilst Mr. P. J. Moore, who is very familiar with conditions in the Moro Province, reports that the actual yearly average yield of nuts per tree in the district of Zamboanga is approximately 45."

COCO-NUT CULTIVATION AND POSSIBILITIES IN PANAMA:

With Some Notes on Catch-crops and Subsidiary Industries.

Except for vastness of area, as is obtainable in Malaya and the Philippines, the coast line of the Isthmus of Panama has always appealed to us as being one of the best centres, if not actually *the* best, for carrying on the "cult of the coco-nut" on a large scale. Panama, we are told, lies outside the hurricane belt of the West Indies, owing partly to the peculiar twist in the shape of the country, which causes a portion of the Pacific (*i.e.*, the west) coast of Panama to be further east than a portion of the Atlantic or the eastern shore is. It is this twist which causes the Isthmian Canal to run north-west and south-east instead of from east to west as many people would, offhand, say it did. Being thus sheltered enables the coco-nut palms to get plenty of wind, which they like, but not enough to break them or blow them down, even on the Atlantic side, where the winds in the winter are decidedly strong. A good proof of the absence of wind-mischief, we are told, lies in the fact that on the islands dotting Panama

Bay (Pacific side) may be seen coco-nuts palms down to the very edge of the water, with absolutely no protection from the winds, and although some are said to run up to ninety and even a hundred feet high, they are, in spite of their age, for many are very old, still whole and sound throughout. This shows protection, for, as everyone knows, the wind can and does blow some good gales in the Gulf of Mexico and about the Caribbean Seas.

A sufficiency but not an over supply of wind, therefore, is one advantage claimed for Panama as a coco-nut centre; another is its favourable rainfall. Estimates as to what the rainfall for coco-nuts should be vary considerably, ranging from 60 to 100 in. Probably different centres need varying quantities. On the other hand all agree that, given good drainage, the coco-nut palm has still to be grown that shows signs of having had too much rain. In 1909 the Isthmian Canal Commission's records showed that at Puerto Bello, on the Atlantic coast of Panama, about 20 miles from Colon, a rainfall of 237·28 in. was registered; this is sufficient even for the thirstiest coco-nut. Adequate rainfall, therefore, is advantage number two claimed for Panama; a third is the lie of the land and nature of the soil. About half a million nuts are shipped monthly from Panama to the United States, chiefly to New York and Philadelphia. These are the famous San Blas nuts, so called because

they come from the San Blas Indian coast of Panama. As stated elsewhere, they are said to be the finest in the world, and claim to enjoy the very highest price on the New York market of any nuts.[1] These high prices are due to the size of the nuts, or rather to the size of their contents, which are richer, thicker, sweeter, and whiter than their less highly priced rivals. Those having to remove the meat tell us also that the San Blas nuts are "free-shellers," *i.e.* the meat can be easily removed from the shell by machinery, whereas with other nuts this must be done by hand. We cannot say if this is always correct, but give the information as received from those who are interested in San Blas. The nuts certainly run large, and if the palms yield as well as reported, both quality and weight will therefore be obtained from them. In answer to inquiries we are told that their average weight runs from 165 lb. to 170 lb. per 100 nuts, such nuts selling in New York during 1910 at from $33 to $40 per 1,000, and at the end of 1911 or beginning of 1912 at $48. These values, we would say, must undoubtedly be due to the soil and situation of the Panama groves. Whatever the causes may be, whether wind, sea-air, plenty of air, salt breezes, plenty of subsoil, water always ebbing and flowing, or for any

[1] We are told, for instance, that on October 13, 1911, San Blas nuts realized $48 (£10) per 1,000, f.o.b., New York, against $34.50 for Jamaicas, also fine nuts.

other reasons, there is no doubt that the palms that have hitherto been produced along the sea shore, in the immediate vicinity of, and so influenced by, the salt breezes from the sea, are superior in quality, in size and in yields to those grown up in the hills or further inland. Whether science and patience in the Philippines can prove otherwise yet remains to be seen, but science and patience cost money and time, and as one meanwhile can grow very fine, if not the finest, nuts in Panama, this centre certainly deserves attention from the prospective planter, be he an individual or a whole company. From what we hear, the low-lying stretches of sand near the Isthmus are mixed with loam; in fact, one description speaks of the soil as being formed of loam with a good mixture of sand, crushed shell, and other matter to keep it open and friable. Such soil certainly appeals to us as being eminently suited for coco-nut cultivation.

San Blas is on the Atlantic side, east of Colon, and therefore north of the City of Panama, itself lying on the other (Pacific) side of the Isthmus. The Pacific nuts are rather more squat, or less oblong. Pacific planters or owners, however, assert that New York and other experts claim that the western nuts are equal to the San Blas. This is not unlikely, for although we use the term "western" the best lands on the Pacific coast are south-south west, rather than west, if our boxing of the

A Fine Panama Seedling.

compass is correct. The Pacific nut is also described as a free-sheller, with the same white sweet meat, *and*, claim its admirers, the nuts will probably run a little *larger*, certainly not smaller, than those from San Blas.

We have dwelt rather fully on these points, as we have not seen them in print (we owe them to the courtesy of some good friends interested in planting within the Canal Zone), and we feel that planters elsewhere than in Panama may be glad to compare these particulars with their own nuts Should they wish to obtain some Panama seed nuts, which we believe can be purchased, to plant on their lands, they must see which suit their locality best, local nuts, or those they propose to import. We have often been asked for particulars of these nuts, and so seize the opportunity of answering the various queries raised at once and for all time.

As is now generally recognized, the ebb and flow of water in the sub-soil of coco-nut lands suit the trees. For this reason some claim that an additional advantage for Panama as a producing centre lies in the great difference between the rise and fall of the tides, which register at times as much as 22 ft. on the Pacific coast of Panama. Such a fall would certainly assure good drainage, enabling, it is said, the mangrove swamps even to be planted with coco-nuts satisfactorily; for although the water rises over their feet, since they are not

covered by it for very long (three hours at the most), no harm seems to accrue to the palms.

Coming to the question of returns, if Panama claims the finest nuts, it also claims the finest yields, but in this it is not peculiar. Without saying what the maximum is placed at, we will say that the minimum is given as being eighty nuts when the palms are in full bearing; a great deal depends, however, the chronicler allows, on the nature of the soil, the location, and the care bestowed on the palms, especially on keeping the "bush" down. Another planter claims that an annual crop of 100 nuts per palm is a safe and conservative average. This, says another, is probably a low average, but there seem to be no reliable records over any period of actual yields. It can, however, be said, we should imagine, that the yield runs over the generally accepted one of forty to fifty nuts per palm, and the net annual yield or value per palm, which was put ten years ago at $1, is now placed at a much higher figure; furthermore, the estates as a whole do not seem to be over carefully attended to.

We come now to such questions as the age at which the trees will bear, when they can safely be allowed to do so, when they come into full bearing, and for how long they will last. On the last point trees are spoken of as "going strong" at ninety and a hundred years old in the most favourable corners. The age at which the palms commence bearing is bound

to depend upon climatic and soil conditions, and also to the care and culture bestowed upon the estate. Here is one return: "Under favourable conditions, as exist along the seashore, the palms will come into bearing between the fifth and sixth year. While there are those who claim that the palm will bear during the fourth year, yet this is a rare instance. Its first crop is a light one, increasing with each succeeding year, producing probably 15 to 20 nuts the fifth year, 50 to 60 nuts in the sixth, and full bearing (whatever that means) in the seventh year."

The average price of San Blas nuts on the New York market was $32 to $40 per 1,000 (even up to $45) in 1910, now they are up to $48. Once, therefore, the actual yield can be ascertained, and our readers can jump at their own conclusions as to what this may possibly be, then we can easily value the annual yield of a palm. Against this the cost of caring for the palms throughout the year, of collecting and husking the nuts, of bagging and transport to New York, and all incidental charges, is put down as being from $10 to $15 per 1,000; leaving, if this is correct, a profit (even at $15 cost) of $18 up to even $33 per 1,000 nuts at the prices reported above as ruling in New York.[1]

[1] Messrs. Gordon, Grant and Co., Ltd., Port of Spain, Trinidad, B.W.I., gave the following quotations for Trinidad coco-nut products in their over-seas circular, dated January 22, 1912: "Coco-nuts per 1,000 f.o.b.

Coco-nut growing in Panama is not a mushroom industry. Balboa[1] reported that he found dense groves of coco-nut palms along the Pacific coast of Panama. De Candolle, we believe, expressed the opinion that the coco-nut palm probably originated on the islands and coasts around the Gulf. To-day, the improved railway facilities now being arranged, *plus* the opening of the canal lands in the Isthmus, tend to run up the value. It is only to be hoped that the speculators will not try to run them up to a fictitious price, as by doing so they would give what promises to be an exceedingly prosperous industry a serious

Port of Spain, $32 in bags for large peeled." Freight, &c., has to be added to this price before the comparative price of $48 for San Blas nuts (probably now still higher) can be arrived at. Against $32 for large nuts in bags, Trinidad was quoting 4·25 cents per lb. for copra, and 96 cents per gallon for oil. Except for the throw-out nuts no one, however, troubles to make copra or oil for export at such prices for the nuts, although, owing to the large number of East Indian coolies in the Island, there is a fairly substantial local demand. The exports of coco-nut products from Port of Spain are returned as follows (for prices in 1913, see end of book):—

	Coco-nuts.	Copra, bags.
1888	10,151,228	—
1898	12,430,016	—
1908	16,622,708	18,220
1909	19,158,513	15,247
1910	19,768,223	12,494
1911	20,466,209	10,315

[1] Vasco Nuñez Balboa, the Castilian, who crossed the Isthmus in 1513. He was beheaded in 1517.

set-back—one too, should it cause the boom to pass them by, that they will not recover from for many a long day.

Regarding catch-crops in Panama, the friends who supplied us with the preceding data also sent us the following particulars *re* catch-crops and subsidiary industries in connection with coco-nut planting on a large scale. These of course refer exclusively to Panama, but we know several centres, particularly in the West Indies, where the advice here given could well be carried out.

"The fact that it is possible to raise vegetables or ground provisions between the growing palms, without injuring them in any way, enables the planter to realize a good profit from his coco-nut lands whilst waiting for them to come into bearing. On Venado beach, on the Pacific shore, at the present time there exists a coco-nut plantation of palms ranging from twelve up to twenty months old. They are in excellent condition, the best methods known being in use, and the palms give promise of early bearing. The seeds were carefully selected from the same Pacific side, the very best only being used. Here also are raised large quantities of ground provisions or vegetables, whichever term you prefer to use, as tomatoes, cucumbers, sweet potatoes, water-melons, yams, yuccas, plantains, &c., whilst of fruits there are bananas, paw-paws, oranges, limes, &c. The latter, growing on trees and

being a permanent crop, were not, like the bananas, grown between the palms, but are on the estate."

In Panama, the Panama Railroad Company and others are purchasing great quantities of vegetables at the time of writing. The Commissary Purchasing Agent in Panama buys in the open market, paying about 20 per cent. less than the retail price at which the vegetables are sold. In spite of this, nearly twenty tons of tomatoes a month are reckoned on as having to be imported, yet every one of these could be produced around Panama. The price realizable is 5 cents per lb., and at this price, in spite of undoubted difficulties to contend with (compared to tomato culture in the United States) a handsome profit could be realized by the owners waiting for their groves to come into bearing. The same with cucumbers, water-melons, beans, yams, sweet potatoes, &c., which are being largely imported, as well as onions and salads; all these could be raised on coco-nut lands.

Then, again, many centres urge that cattle and hogs can and should be raised on coco-nut estates to feed on the poonac, and so nourish themselves and then the soil whilst yielding a profit to the estates. Fresh milk around Panama is very scarce and dear, about $1.50 a gallon. It would therefore pay even to run a dairy, especially where grass lands prevail, as they do at the back of the beach at Venado. Cattle fattening is also very pro-

fitable around Panama, and many men have made fortunes out of the trade. After bananas it is one of the most promising industries to-day. The rearing and fattening of cattle is further to be recommended, because guinea, para, and other fattening grasses on which the cattle can graze and fatten, may be planted between the coco-nuts, once the palms are sufficiently high to prevent them being harmed. This is, we understand, a favourite method in Ceylon, where there are some ninety million coco-nut palms in bearing. Round Panama poultry and eggs are also selling at very high prices, such as 70 cents to $1 for fowls, and 50 cents to 60 cents per dozen for eggs. Even at these prices the demand seems endless.[1] With the poonac available for local or inter-State supplies, pigs could also be raised at a good profit. As regards cattle, it seems possible to buy lean animals in the interior at about $20 each, which in about ten months' time, with the feed obtainable on a well-managed estate, should be saleable around Panama at $35 to $40; whilst the consumption, already beyond the supply, is, in common with all foodstuffs, expected to greatly increase when the Canal is opened, and the resultant trade

[1] This must be owing to the Canal officials. Although the price of poultry and eggs does run high in the West Indies, such rates as above cannot be relied on to last. The *Costa Rica Bulletin* was recommending the rearing of pheasants and chickens on the estates, not only for food, but as insect destroyers.

and traders settle down to steady work. There are no figures available for hogs, which, the same as we have seen in Venezuela, are allowed to run wild, going around village and town, scavenging for food like pariah dogs. Even then they pay, but if compounded at night and fed up, their flesh is greatly improved at very little cost, and whilst their manure can be utilized, the value of their carcases is more than doubled both in quantity and quality, *i.e.*, in weight and value. Pig-raising, as done in England with its dairy-fed pork, is unknown in Central America, but that is no reason why a start should not be made. When you are told, as the writer was at Carupano, in Venezuela, that no wise woman leaves very young babies in the cradles unguarded lest the pigs should "injure" them, one can easily realize what these round-backed, tusked, decidedly savage animals can and do eat, when allowed to scavenge around for a living like wild animals; yet these same pigs, if fenced in and well fed, improve in shape, weight and manners in an incredibly short time.

THE COCO-NUT PALM IN SAMOA AND NEW GUINEA.

THE following remarks are based on a very interesting article published by the *Tropenpflanzer* of Berlin from a report drawn up by Prof. Paul Preuss and translated from the German by Mr. Pape.

In the Samoa group of Islands there are four main cultures: coco-nut, cacao, rubber and "ground vegetables," such as kawa, taro, tapioca, &c., but, of all those enumerated, the coco-nut is by far the most important, and represents the chief property asset of the Islanders. Its culture has already achieved some very remarkable results, and the present area under cultivation with it, leaving out the native plantations, comprises no less than 7,000 acres, whilst the number of palms thereon may be computed at about 325,000. Besides these the number owned by the natives cannot be less than 700,000, making at least 1,000,000 palms in all. Meanwhile of copra there was exported within the last few years:—

In 1899	... 7,792 tons.	1903	... 7,614 tons.
1900	... 6,450 ,,	1904	... 7,446 ,,
1901	... 4,576 ,,	1905	... 8,603 ,,
1902	... 7,922½ ,,		

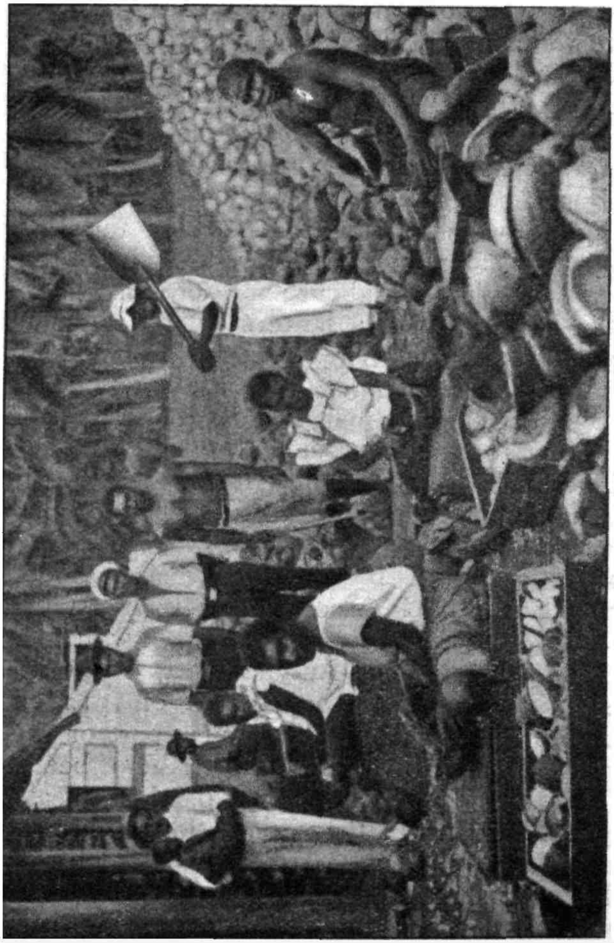
Average, 7,200 tons.

And the export continues to rise steadily. Placing the production of the plantations at 2,500 tons, there remains for the native holdings the respectable amount of 4,700 tons. This must be accounted a very fine result taking into consideration the indolent nature of the natives, the striking preponderance of whose cultivations over those of the Europeans is very evident, and gives a fine testimonial of the intelligence and high level of culture of the Polynesians. We mark quite the reverse in New Guinea; here, although the number of palms in the hands of the natives is by no means less than in Samoa, the lower type of native does not produce from them one-half the quantity of copra that is obtained by the Samoans. On the other hand, the coco-nut plantations of the whites in German New Guinea are of far larger extent, and already contain over a million trees, of which the New Guinea Company alone owns 600,000. The present rather low export from this centre is due to the comparatively young age of the trees.

In Samoa the coco-nut palm represents the real tangible estate of the natives, in the same degree as does the oil-palm in West Africa and the date-palm in North Africa. It is essentially the best tree for native cultures. The far-sighted Governor of Samoa has recognized this fact, and for several years there has been in force an ordinance which compels every Samoan to annually plant not less than fifty

coco-nut trees. The benefit of the measure is hardly yet apparent, for with the paucity of care which the native is wont to bestow upon the trees, they do not come into bearing until the seventh year or even later. The advantage of the measure will, however, be shown in a few years' time in higher export figures.

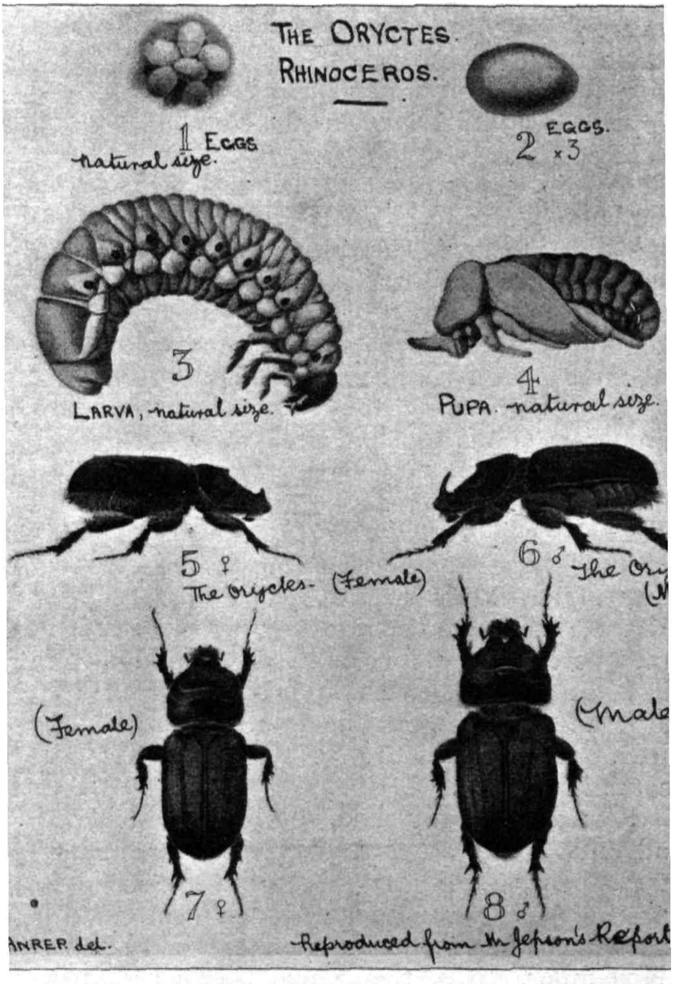
For Europeans the cultivation of coco-nuts is only to be recommended under the two following essential conditions, namely: first, cheap and plentiful labour; and secondly, plantations laid out on a large scale. For small holders the returns per acre are too small, and if the expensive Chinese labour has to be imported there is no margin for profit. It also remains to be seen how the independent Chinese labourer, specially imported and not in his native place, will work and behave under German discipline. The above conditions are both carried out by the Deutsches Handel und Plantagen Gesellschaft, and their estates therefore deserve careful attention. Mr. Frank Jepson, Government Entomologist, Fiji, who visited Samoa in the early part of 1912 on purpose to study the habits and report on the extent of the ravages of the Rhino beetle (*Oryctes rhinoceros*) in the island, when speaking in his report of these plantations, said that they "stand out as conspicuous examples of what can be done to control the pest by clear cultivation." Neglect, on the other hand, it is asserted, has caused planters in Cambodia



PREPARING COPRA IN SAMOA.

Annam, and elsewhere to have suffered severely from the depredations of the Rhino beetle. This company has held a concession from its inception which gives its directors the right to recruit labour up to a certain amount from the Islands of the Bismarck Archipelago. The main reason also of its success is that the bulk of the trees are in full bearing. At one time in Samoa the cultivation of the coco-nut palm enjoyed the great advantage over other producing centres of being free from any kind of disease or insect pests but a restricted labour supply engenders carelessness in some respects and tends to cause constant and proper weeding, hoeing, and, most certainly, manuring, to be neglected. With regard to the nuts themselves, it is worth noting that according to Mr. Jared G. Smith, of the Hawaii Experimental Station, in the *Philippine Agricultural Review*, June, 1908, vol. i, No. 6, the Samoan coco-nut is considered the best variety for cultivation in Hawaii because it commences to bear at an earlier age, and is more prolific than the Hawaiian tree. The palms are at their best further south in Hawaii.

Samoa generally had, until 1910, a great advantage over other producing centres in her trees being free from disease and pests, but, alas, as Mr. Jepson's report already referred to shows, it is now known that, as far back as November, 1910, the Rhino beetle set forth


THE ORYCTES RHINOCEROS.
1 EGGS natural size.
2 EGGS. ×3
3
LARVA, natural size.
4
PUPA. natural size.
5 ♀
The Oryctes- (Female)
6 ♂ The Ory
(Female)
(Male
7 ♀
8 ♂
ANREP del.
Reproduced from Mr Jepson's Report

unnoticed or unheeded from the Custom House at Apia to spread trouble throughout the German island of Upolu, on which Apia is situated, and has been busy spreading trouble ever since. The prevailing belief is that the pest was introduced in boxes containing rubber stumps, packed in soil and vegetable refuse, at a time, unfortunately, when no system of inspection and protection had as yet been introduced, and so the beetle ran riot before the authorities realized what a "snake in the grass" had crept unnoticed into their hitherto happy little island. "It is a significant fact," wrote Mr. Jepson in his report,[1] "that the spread of the beetle from Apia has been, in a large measure, influenced by the north-east trade wind. In the prevailing direction of this trade wind one may find occasional areas which show no indication of having been visited by beetles, and in many instances these areas are sheltered from the wind either by hills or by belts of forests.[2] Of the affected palms 30 per cent. had their yield reduced to a great or small extent by the destruction of

[1] Bulletin No. 3, Department of Agriculture, Fiji, being a report on "The Rhinoceros Beetle in Samoa," by Frank P. Jepson, B.A.Cant., F.E.C., Suva, Fiji. S. J. March, Government Printer. Price 1s. net (probably including postage). Planters should try and secure a copy of this exhaustive, illustrated report on the pest to which we owe the illustration opposite.

[2] See "Notes on Soils and Plant Sanitation on Cacao and Rubber Estates" *re* the advantages of maintaining forest belts to keep off the wind and restrict pests.

Mr. Barrett specially recommends the cacahuate on account of its being a shrub or small tree that may readily be grown from cuttings stuck in the ground. It can be cut back whenever its height exceeds $1\frac{1}{2}$ to 2 metres, the loppings helping to increase the humus layer on the ground. A drawback is the shedding of the leaves in the dry season—that is, just when the protection is most needed.

Some of the young plantations have catch-crops, such as sweet potatoes, arrowroot, tapioca, taro, yams, and also maize, bananas, hill-paddy or rice, beans, and peanuts, whilst cotton, chillies, citronella and lemon grass, patchouli and castor beans are also to be met with. But these crops can only be carried on for a restricted number of years, on account of the palms covering the ground when planted as close as 10 ft. by 10 ft. Interplanted cacao and rubber have also been tried, but with doubtful success, and such a plan is not to be recommended, although the two crops could be grown on the same estate in belts in order to restrict disease, and distribute the financial risks of the owner, if the soil and climatic conditions are suitable.[1]

Interplanting has, however, generally given way to cattle in the end, and although doing so requires a good deal of capital to buy the

[1] See "Notes on Soil and Plant Sanitation on Cacao and Rubber Estates," by H. Hamel Smith, *Tropical Life* Publishing Department, London, price 11s. post free.

animals, the results evidently are satisfactory, as about three head can go to the acre. In spite of this, although the Deutsches Handel and Plantagen Gesellschaft owns for this purpose a herd of 2,500 head, to their total area of about 7,000 acres, it has been said that a great deal of their cleaning has still to be done by hand, which is expensive. To use cattle, therefore, to effectually keep down the weeds a large number is necessary. But still, even a few cattle, such as one can afford to buy at the start, is better than the dilemma of some of the Pacific Isles, where the insidious lalang grass grows and shoots up in the course of a few weeks to the height of three or four feet. The roots of this grass also "felt-up" the surface and impoverish the soil very considerably,[1] and while full-grown cacao and rubber trees do not allow it to grow under their dense shade, coco-nuts, even when full grown, are too far apart to keep it down, and it is extremely costly in many places to eradicate. In some localities, where the ground is fairly level, the grass is actually kept down by mowing machines, and elsewhere by repeated ploughing, but this latter is said to damage the coco-nut roots, and the appearance of the palms soon shows this. Ploughing, however, is probably the lesser of two evils and is recommended in the Philippines. At

[1] Barrett in his "Coco-nut Culture," p. 12, claims that the poisonous effects of cogon grass and difficulties of soil ventilation retard the profit-yielding age of palms.

any rate in the German colonies the danger of fire during the dry season is very great in those plantations where grass of this sort abounds. Some people in preference to ploughing have therefore planted the creeper *Passiflora fœtida* under the coco-nut trees with fairly good results, because this cover-crop keeps the ground covered, is nitrogenous, and does not burn, and so it is agreed that if not planted throughout the estates it should at least be employed where "fire-lines" are established, and where there are no cattle. Where cattle are kept it will pay to cultivate food-grasses, such as buffalo-grass (*Monerma repens*), and what is locally known as couch-grass. Vailima grass is better still, whilst the best for cattle food value is the Samoa grass. The most advantageous for the well-being of the palms, however, is the mimosa (*pudica*), which, as a leguminous plant, is able to collect nitrogen from the air, and is reputed to contain over 20 per cent. of proteins against about 8 per cent. in common meadow grass. The mimosa is a very nourishing cattle food when once the kine have taken to it. Again, directly this mimosa has gained a firm hold it is impossible to eradicate it, and it will kill out all other weeds. A drawback is the fact that it is covered all over with spines; these will wound the natives going about the plantations to pick up the nuts, &c., and even the cattle as well. As the natives are very prone to sores on the ankles and the lower part

of their legs, this is serious, and must be taken into account. Where cattle are not sufficiently numerous to keep down the mimosa, it has to be done by slashing with cutlasses or bush-knives. As regards planting there is still some difference of opinion as to which is the best way, *i.e.*, whether the nut should be planted point down or on its side. On the whole, it certainly appears right to assume that it should be laid on the side. In this way the roots have only to penetrate a very short thickness of the husk before they reach the surface, and it will be observed in the vast majority of cases that the nuts lie on their sides under the trees and not standing on their point. Compare the illustration of a Coco-nut nursery in the Philippines in "Seed Beds and Nurseries," where the nuts seem mostly laid on their side, with the American (on p. 110) holding up the nut which has been planted upright. The pointed end appears, therefore, rather as a lever to turn the nut on its side when it reaches the ground, whilst the shifting centre of gravity, viz., the milk inside, further helps to lay the nut flat rather than upright. The flat side, on the whole, is evidently the right one, for it affords the quickest and easiest way for the roots emerging from the germinating hole to reach the soil, although the upright growth gives one the idea of forming a more perfectly grown tree.

Another cause of controversy is whether it is more judicious to plant the nuts right out

into the field or keep them for a while in nurseries. The answer largely depends on the situation, and whether there is fear of ravages and damage by pigs, rats, &c.; all things being equal, the former practice, *i.e.*, planting in the open, may be resorted to with advantage, but the nursery system also has its many advantages, as it provides a chance for constant and close care, and when once the young nurslings have attained some degree of sturdiness, the selected specimens only need be planted out. This avoids to a considerable degree the costly and tedious task of filling gaps in the widespread area of the full estate, and also ensures more even planting of only picked seedlings.

In New Guinea the following method is in universal vogue: the sound ripe nuts are collected in a shady centre and placed on the ground (not bedded in) against each other on the flat side, of course in the rainy reason. As soon as they have germinated and the young leaves are about 8 in. high, the planting out commences. It is claimed that no advantage accrues by leaving them to further develop, for it is found that they sprout and grow very rapidly after transplanting, and soon catch up even with those which have been left longer in the compounds, as the latter take longer to "take hold" after transplanting, and this seems to cause them to experience a set-back in their growth. Very young plants have

to be watched against the depredations of the black labourers, who root up and split open the nuts for the sweet pulpy germinating heart of the plant (a great delicacy), and as this causes the best nuts generally to be chosen, the loss is serious in more ways than one.

In virgin land the planting out of the young seedlings is unsatisfactory, as it causes a heavy bill to be incurred for weeding and cleaning; but it is of great advantage on land which has been cultivated before, and which is comparatively clear of weeds. Holes for planting should never be less than 2¼ ft. square, and filled with made-up soil for the nuts to start growing in. The nuts should be well covered and in order to prevent the young stems from rotting, the holes are left partly open, so that the soil fills them in gradually during rain or when watered. Care must however be taken that the water so collected drains away and does not remain on the top of the hole. Never plant less than 25 ft. apart, and best of all, 30 ft. by 30 ft., as the coco-nut palm requires plenty of light, air and ventilation, and, as stated elsewhere, if the fronds rub together smaller crops result. The evaporation from the palms is also enormous, and they need ample room to perform this function unchecked. A number of trees are often noticed in groups close together, but in such cases it will then be found that the outer ones thrive and bear more freely than those in the centre. Many native plantations have the defect of

being far too closely planted; with more room they could be made to yield much better, and for this reason should be thinned out; but this cannot always be carried out without serious objection on the part of the owners, and in any case it is best to plant wider at the start and so avoid having to thin out later on. The growth of the palms seems to be slower in Samoa than on the Coral Isles of the Pacific, but the foliage (in Samoa) is much more ample and vigorous, the tree bears longer and attains a greater age whilst still maintaining its yield, so much so that many vigorous palms are to be met with that, it is claimed, have proved to be at least a hundred years old.

Under the most favourable conditions the flowering in Samoa may commence in the fourth and the fruiting in the fifth year. The average age, however, for bearing cannot be given as before the seventh year, with an increasing annual output up to the fifteenth and even up to the twentieth year, but full maturity is generally counted as from about the fifteenth year. No careful planter calculates on returns too soon, and so to save disappointment he will figure out one hundred trees per hectare, and for yield of copra as follows: In the seventh year $\frac{1}{10}$ ton, in the eighth year $\frac{1}{3}$ ton, in the ninth year $\frac{3}{10}$ ton, in the tenth year $\frac{1}{2}$ ton, in the eleventh year $\frac{3}{5}$ ton, in the twelfth year $\frac{7}{10}$ ton, in the thirteenth year $\frac{3}{4}$ ton, in the fourteenth year $\frac{4}{5}$ ton. Under

exceptional circumstances a fully matured estate without gaps will yield after the fifteenth year up to one ton of copra to the hectare. These are exceptions and do not take into account droughts, &c., and it must be taken for granted that about every third or fourth year poor copra crops will ensue. In a country like Samoa, when there were no pests, one would have thought that gaps in plantations would not occur, but from one cause or another it is impossible to find a single estate without failures, and this is not to be wondered at, as trees die from many reasons besides pests. The cattle are still the principal offenders in young plantations, where they eat the young leaves greedily, causing the death of the trees. It is therefore necessary to surround them with fencing or a rough wall. The latter is costly and cannot be carried out *en masse*, and in any case 2 to 3 per cent. of the gaps can be put down, even on the best plantations, to natural causes, for it must be remembered that damage is constantly being done even to the full-grown trees by lightning and storms, &c. In Samoa the average yield of a full-grown palm is sixty nuts per annum, the nuts being of medium size. The meat is fairly thick, but it takes about 6,000 nuts to make one ton of dry copra (or nearly three nuts to the pound), although there are some localities where the size of the nuts admits of the making of one ton of copra from only 4,000 nuts. It

is debatable, however, whether such exceptions have any weight in the all-round averages, and it is possible that where the nuts are large their number is less, so the net results work out the same. In Samoa the nuts are allowed to ripen wholly on the tree and then to fall of their own accord. Although some people maintain this weakens the tree too much, still it stands to reason that the plucking of them, however skilfully done, has serious drawbacks, such as damage to the trees themselves and the uncertainty of plucking only ripe nuts. As a matter of fact many nuts not quite ripe and fit are known to be picked, so that some make it a rule that the copra is to be made *only* from fallen nuts. The flowerstalks, &c., are also bound to suffer more or less with hand-picking. Donkeys are mainly used for purposes of transport, the nuts being placed in panniers. Sometimes the nuts are collected in heaps and the husks and even the shells removed before being taken to the factories, and this certainly reduces the bulk to be carried. The opening and shelling on the plantation, however, often results in the meat becoming dirtied in transport, especially if it is raining at the time. In hilly localities it has been found most expedient to erect a number of small drying-kilns at different centres in order to obviate this drawback.

In Samoa large central kilns are invariably the vogue; this increases the transport neces-

sary, as all the nuts are brought to the central kilns. Against this there is the advantage of bringing the fuel (*i.e.*, the husks, which are excellent for this purpose, as they give off a very intense heat) right up to the furnace doors. As the husks of the nuts are not utilized to any appreciable extent for fibre or rope-making either in Samoa or New Guinea, nothing has been lost so far by burning them. The absence of any coir industry in these islands as compared with Ceylon is probably due to the production of coir not having so far proved profitable, although we all know what a profitable domestic native industry this has proved in Ceylon and Netherlands India, where merchants freely buy up the yarn, &c., made by the women and children, principally in their spare time.

The kilns used in Samoa for copra-making are constructed as follows: A lower masonry structure (18 ft. long by 7 ft. high) contains heating pipes made of sheet-iron (2 ft. diam.) laid lengthways. These pipes have a furnace at one end and a tall smoke stack (25-30 ft.) at the other. The masonry walls carry a broad spreading floor with a roof over the whole, whilst over the pipes is a system of hurdles of a handy size (4 ft. by 2 ft.), numbering as many as 200, on which the coco-nut meat is laid. Fresh air and the necessary draught is admitted by means of small holes through the lower part of the masonry.

Such a kiln will dry about 1,700 lb. of copra in 24 hours; this is equivalent to about 23 tons per month working continuously. The flooring under the pipes which surround three sides of the hurdle supports is used to cool off the hot copra as it comes off the hurdles. This cooling must be done thoroughly and efficiently, or the copra, the same as cacao beans, will mildew if packed hot. Like cacao and sugar, therefore, it must be shovelled over and turned frequently to cool. If the kiln is properly worked, the result will be a snow-white, perfectly air-dried copra. The cost of such a dryer is put down at £300 to £350 including the material for the heating pipes, which to save freight and packing is imported in the sheet and bent and riveted locally.

These kilns have two great disadvantages, they totally preclude the action of the sun in the drying process, and further, it is impossible to attend to the important function of turning or moving about of the meat while it is on the hurdles. This is a serious drawback, as it does not allow of an even or thorough drying. This is why rotary dryers are preferred, as such a system removes all these defects, and their initial extra cost of installation is amply compensated by improved and more even results.

There has been one machine installed for drying the copra by means of hot steam, but it does not seem to have proved a success. This is mainly due to the husks being unsatisfactory as

fuel, as they burn down too rapidly. It might be a different story with coal, but then of course the cost would be too high.

There is still plenty of room for the further expansion of coco-nut planting in Samoa, without fear of the supply exceeding the demand sufficiently to reduce profits to too low a level. Granted that the Government succeeds in getting every native to plant fifty trees per annum as legislated for—at proper distances apart—then there is no doubt that the export figures will rise considerably within the next few years; but there are several strong reasons for doubting whether this measure will ever prove effective. There is nothing in Samoa to prevent planting on unsuitable areas, and it would be expecting rather too much from each native to expect him to properly look after the 300 trees which he would own at the end of six years. The native Samoan is by nature so indolent that it takes him all his time to cultivate even the "kawa" required for his daily needs of sustenance; to expect him, being unambitious, therefore, to work without any natural incentive is almost certain to prove a failure.

Let us assume, for argument's sake, that every one of the 17,000 adult males will plant 100 trees in the course of two to three years; this would represent a total of 1,700,000 palm trees, which in a mature state are able to yield the respectable quantity of 10,000 to 12,000 tons of copra. It is hardly conceivable that many

more Europeans will devote their time and their money to the establishment of large coco-nut plantations, at any rate in Samoa, if the law regarding native plantings is enforced. The Europeans, it is considered, are more likely to devote their efforts to rubber and cacao, especially as these latter hold out promises of quicker returns, but at the same time it cannot be denied that a coco-nut plantation represents a substantial, solid and stable property, yielding regular returns, so that anybody who has persevered and brought his estate up to a producing stage can look forward to reaping handsome and steady profits; for there are very few economic plants in existence which will yield such steady returns for from fifty to eighty years, and just now the high price for copra, which promises to be permanent, has brought prosperity to all the coco-nut growing sections, and the area planted in coco-nuts is being largely increased. At the same time we would claim that you can do the same with cacao and rubber, if properly looked after, and for this reason if we went to Samoa to plant—and the Island from all accounts is an ideal centre for tropical agriculture—we would go in for all three products (planted in belts, not inter-planted), cacao, rubber and coco-nuts.

Regarding the output of copra in the South Seas, the *London Chamber of Commerce Journal*, some time back, reported that the principal copra-producing country, after India (and

to this we would add also after the Philippines), is the island of Samoa, where, by regulation of the native methods of cultivation, it has been possible to double the production of this important article within ten years. Thus, in 1900 the annual crop was about 6,000 tons, and in 1910 it exceeded 12,000 tons. It is predicted that, within a dozen years, some 30,000 tons will be produced in the Islands of Samoa alone. At the present time the yield per acre is from 9 to 11 quintals. The production of copra has also recently begun to extend in the New Hebrides,[1] in the Solomon Islands, in Papua, and in certain of the Pacific Islands. All the copra actually produced in these regions goes to Sydney, or passes through that port before being re-exported to Europe. Having regard to the constant development of the production of copra, it is anticipated that Sydney will become one of the most important markets for this article in the world.

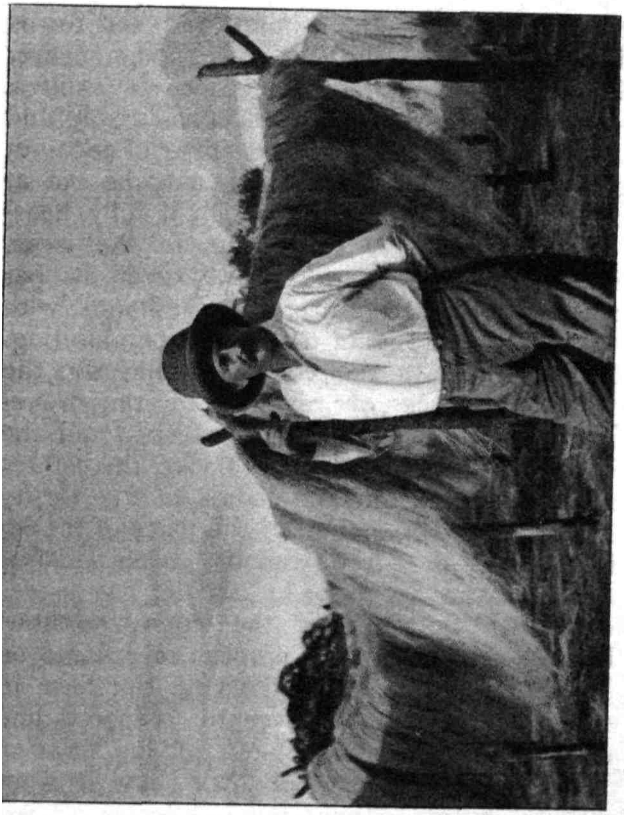
[1] See end of book, *re* New Hebrides.

THE COCO-NUT IN GERMAN EAST AFRICA.

THE coast-line of this colony, extending from the 5th to the 11th degree of latitude South, is low, sandy and of coral formation; it is, therefore, eminently suitable for the cultivation of the coco-nut palm, being broken up into many bays and creeks where rivers and water-courses debouch, and as it also has a number of islands adjacent to it, such troubles as want of transport or sea air, or lack of subsoil water for the estate are reduced to a minimum. The rainfall is fairly abundant, amounting in some localities to 65 in. There are, however, two distinct seasons with long dry spells in between, which is not an over-favourable condition of things for coco-nuts, as they thrive best when occasional showers can be relied upon throughout the year. On account of the extremes of wet and dry, and often insufficient rain, the output of copra in German East Africa is subject to serious fluctuations.

The most extensive coco-nut cultivations are found near the deltas of the rivers. From the Umba River, for instance, which forms the boundary in the north, down to Tanga, a distance of 60 miles, there is an almost unbroken belt

of coco-nut palms, whilst the Pangani River delta is another producing centre. The rivers Saadani, Kingani, Wami, Rufiji (with the islands of Mafia and Chole), and the towns Kilwa, Lindi, Mikindani and Kionga nearer Cape Delgado, all have their coco-nut estates, forming in the aggregate a considerable and important area. The total number of coco-nut palms in German East Africa may be put at over a couple of millions, which if fully bearing mean, at only forty nuts to the trees, 80,000,000 nuts in the year. Over 80 per cent. of the holdings are in native hands, with the Arab and Indian owners preponderating. In the old days the coco-nut palm was the principal source of revenue of the slave-holder. After slavery was proscribed and the Arabs lost their grip on the blacks, the estates passed rapidly into the hands of the thrifty traders from Hindustan, in the place of the indolent Arab over-lord, who had been satisfied to just sit on his property and let the slaves look after it and get the copra anyhow. There were plenty of European merchants on the spot, even in those days, to purchase it, even if it was but indifferently prepared, and so long as the Arab master got his share of the dollars he cared but little how it went with his trees. Hence the indifferent reputation which East Coast copra has enjoyed for many years in the past, and which even now remains to it to a great extent, for even the



Mr. Pape superintending the Drying of Sisal in German East Africa.

successors to the Arabs, whether the East Indian or otherwise, seldom if ever see any palpable advantage in careful culture and systematic working or preparation, Again, the conduct of affairs is still to a considerable degree dependent on the goodwill of the negro or native black, who is inordinately fond of intoxicants, and the easiest way to satisfy this craving is to tap the palm for its sap, which, when fermented, yields a very potent beverage, pleasant to the palate of the African worshippers of Bacchus. For tapping the juice, the flower stalks are tied together at the ends, which are then cut off and a vessel is hung underneath to catch the sap running out (see illustration in the section devoted to alcohol). While this tapping is said to be harmless on young vigorous trees if carried out moderately, the native method of carrying it out to depletion is quite the reverse, the consequence being that thousands of the trees are destroyed annually by this means alone. As long as there is no law prohibiting it and the natives can openly offer the palm-wine for sale in the streets, there appears to be no remedy, and the wholesale destruction will go on unhindered. Even on the white plantations it is extremely difficult to exercise sufficient supervision over the trees to check the evil. This palm-wine tapping in East Africa does far more damage than all the rest of the enemies put together, and legislative

measures are necessary and should be passed to cope with the matter.

East African coco-nuts are rather small in size, and it takes well over 7,000 to make a ton of copra. This is entirely due to close planting and insufficiency of care. In European plantations the trees yield full averages of big fruit. All the copra is made by native methods, and as there is copious sunshine all the year round, there is not much difficulty in the proceeding. But the natives are so full of duplicity and crafty guile that they frequently only half-dry the copra in order to keep it heavy, so that the merchants are generally forced to subject it to a second drying on their own account, with the result that the bulk mostly turns out uneven, and of indifferent quality. Such copra fetches but a low price, being only fit for the lowest purposes of manufacture.

Some years ago a healthy development in European cultivation sprang up, when some promising and extensive estates were formed. But even their copra-making methods leave very much to be desired. Although the Deutsche Ost-Afrika Gesellschaft have always owned the pick of the large estates, they somehow have not been able to make them much of a success, owing probably to the lack of enthusiasm and the antiquated methods still employed. It was unfortunate for the coconut industry of this colony that eight or ten

years ago they experienced a phenomenal boom in the growing of sisal hemp, when, encouraged by the promising results obtained about 1905-6, numerous planting enterprises sprang up everywhere and, in many instances, earned dividends of 35 per cent. and over. So successful did these sisal estates prove during this boom that "mature coco-nut trees were cut down" to make room for the favourite sisal. With the reaction in sisal prices, just now particularly low, people are beginning to revert once more to the staple products, and as it has been proved that many thousands of acres of the coast lands are eminently suitable for coco-nuts, a healthy development in this direction is taking place under European auspices, and should continue to increase.

While there is not exactly a plethora of population on the coast, there should still be sufficient to warrant development on a liberal scale. For coco-nut planting is decidedly a congenial occupation with the natives and they would flock to such enterprises in preference to the more arduous sisal or rubber planting. The Swahili of the East Coast of Africa is a docile, tractable and physically well-favoured individual, and given the right treatment and management can be made to turn out a fair day's work, but to make him persevere and stick to his task is a different matter, and therein lies the trouble. As the nature of the coco-nut industry is such as to allow of many idle or

comparatively easy spells, this lack of application in the labour material can be made to dovetail in with the requirements and exigencies well enough to guard against loss. Gradually, as the native realizes that the power of money is bound up with his well-being and small ambitions, this drawback will disappear, and he will generally be found to settle down and work diligently. A proof that matters are rapidly mending in this direction is the steady rise of import figures for such commodities as cotton piece goods, cutlery and fancy goods; and, furthermore, the native dwellers in the towns show a desire to live in clean, decent, roomy houses, and this tendency is spreading to the country-side.

The average rate of wages for an adult works out at about 6d. per diem, but the natives from the interior, who gladly come down to the coast on contract for six months or less, accept a much lower rate of remuneration. The price of land is not at all high or prohibitive, and averages from Rs. 5 to Rs. 10 (R=1s. 4d.) per acre, according to locality. The Government own vast stretches of unoccupied land, which may be obtained at even cheaper rates. In the case of native holdings and plantations it is almost impossible to get valid titles. The real ownership claims are vague and generally constitute a verbal family arrangement, complicated by modifications and ramifications dating back to many generations. Further

legal difficulties are encouraged by the owners being amenable to Arabic law, with its quaint and intricate forms. The course to be recommended therefore is to select and make application for Government or European owned land *only*, which will save much disappointment and subsequent litigation, as well as costing less. In conclusion, it is worthy of note that this coast is free from destructive storms; it is, moreover, in the zone of the trade monsoons, which blow steadily for many months' duration and are on the whole very beneficial to the growth of the coco-nut palms, as they are generally accompanied by heavy showers of rain. For these reasons, therefore, a well-established and properly managed coco-nut estate in this region should provide a substantial and steady revenue.

COCO-NUT PROSPECTS IN MEXICO.

THOSE who know Mexico, especially the Oaxacan Valleys, or down Tehuantepec way, and the lands of Tabasco and Chiapas, have always been puzzled as to why these fertile terrains have received such scant consideration at the hands of the Mexican authorities. Investors have hitherto confined their attention to minerals rather than to agriculture, and until quite recently even the authorities have made but little attempt to encourage farmers and landowners to develop agricultural industries. But powerful friends to legitimate exploiters of her lands are now said to be in the ascendancy in Mexico, chief of whom is the present Minister of Fomento, Señor F. L. Hernandez, who, commenting on a communication of Mr. Alfred de Berry as to coco-nut planting in Mexico, writes as follows: "The States you mention (Chiapas and Tabasco) are singularly blessed by nature for such extensive cultivation as you have in view—coco-nuts and bananas—the Department will do all it can to assist, etc." It may be generally accepted that the time has come when the planters may count upon the active sympathy, support, and protection of the Mexican Govern-

ment authorities, no matter which political party may be in power. Of all agricultural opportunities which offer in Mexico, the planting of coco-nuts presents the greatest potentiality. Some maintain that Mexico is too far north for the proper production of the coco-nut palm, but according to official figures furnished by the Mexican Government Financial Agency in London, where a fine collection of Mexican productions may be seen, Mexico exported in

1906-7 ..	33,032	kilos of coco-nuts
1907-8 ...	67,481	,, ,, ,,
1908-9 ...	70,556	,, ,, ,,
1909-10 ...	163,715	,, ,, ,,

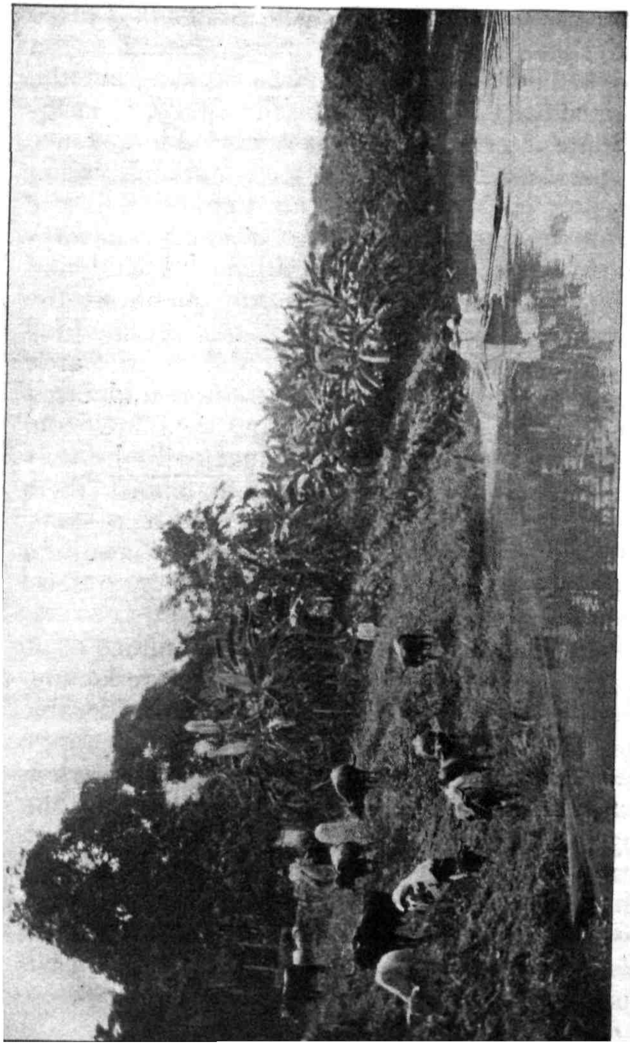
This quantity is, of course, absurdly insignificant in view of the vast areas of Mexican lands suitable for coco-nut planting, but the truth is that no attention has been paid to the exploitation of the palm in Mexico, and extreme ignorance prevails on the subject. Mr. de Berry, as a result of his eight months' tour, when he made careful notes on the subject of coco-nut lands, whilst examining some of the chief plantations of rubber, cacao, sugar, &c., in the Republic, maintains that in Oaxaca, the Isthmus, and the State of Vera Cruz, coco-nut culture is almost *nil*, but small plantations exist in Chiapas and Tabasco. This authority was speaking, of course, just after President Diaz had left for Europe, but *when* peace reigns again there are undoubtedly tens of thousands of acres of ideal land, from the coco-nut planter's

point of view, to be met with in Mexico; lands which are annually overflowed in a manner comparable only with the inundation we associate with the Nile, and, therefore, very suitable for producing large regular yields. Tabasco, especially, he maintains, should be one of the most important centres of coco-nut production in the world, as the acreage is vast, the soils are light, rich, and deep, and sometimes, as at Frontera, calcareous. The roots of the palms, therefore, will have the necessary amount of water, which, with the requisite mineral and other plant foods held in solution, constantly seeps down toward the rivers. This underground water movement would exert its great potency upon the palms, constantly refreshing the feeding area of the roots. Accompanying other advantages is high illumination of the air, and all the conditions for perfect transpiration, and planters of reliable testimony maintain that trees of fourteen years yield as many as 200 nuts per annum.

Mr. de Berry further states that he examined fine specimens of nuts taken from palms in Chiapas, 120 miles inland, and he also inspected excellent fruit on the Isthmus, as at the Dos Rios Estates, 90 miles inland. In Oaxaca is also produced a small quantity of coco-nut oil. The palms grow luxuriantly near Colima, and in Juquila the palms of the Corozos prove the suitability of the soil for the growth of the coco-nut. A palm yielding a

small coco-nut is found in the States of Jalisco and Sinaloa There are more plantations on the Pacific than on the Atlantic side, but the planted area in Mexico, on the whole, is insignificant at present. As a remarkable instance of the lack of attention coco-nut cultivation receives in Mexico, we can mention that the handbook issued by the National Railways of Mexico in 1912, entitled "Facts and Figures about Mexico," hardly mentions the name of coco-nut, although pages are devoted to Mining and Hunting, as well as to Cattle Raising, Sugar, Pineapples, Cotton and other productions. Notwithstanding, we are told that the Mexican Government will heartily welcome English planters and afford them every facility for the planting of coco-nuts, and that there are assured fortunes awaiting the right type of man who is willing to seize such opportunities by the forelock.

In Mexico the cattle industry is confined to no particular section. Where the rains are lacking for part of the year, as is the case in considerable portions of Chihuahua, Nuevo León, Durango and Coahuila, the grass in ordinary years is sufficient for grazing, but hardly for the fattening of the stock; often, however, the thin stock from the northern part of the Republic is fattened on the haciendas of the central and southern portions, and this is where the large coco-nut planter would get his chance to buy lean beasts and fatten them up on his richer grass lands and



CATTLE AND BANANAS IN MEXICO.

poonac. Of late years a cattle-raising industry has grown up in the eastern districts of the States of San Luis Potosi, Southern Tamaulipas, Vera Cruz, Oaxaca and Chiapas, which, although still in its infancy, is important. Taking advantage of the wonderful properties of the pará grass, the stockmen in these regions purchase lean stock in the grazing countries of the northern part of the Republic, and fatten it for the Pachuca, Puebla, City of Mexico, and Yucatan markets. Lean stock can be bought reasonably according to age and condition. It is estimated that two acres of good pará grass, if cut and fed, will feed three head of stock the year round; in pasture four acres will fatten four head. The grass is evergreen, of luxuriant growth, very nourishing, and will exterminate all weeds.

There now seems no question but that on account of the large ranches being rapidly broken up in the United States, and subdivided for agricultural purposes, Mexico is bound to become the breeding-ground of the American beef supply. The northern portion of Mexico is generally of high elevation and has millions of acres remarkably adapted to cattle breeding; but on account of the long dry season in some districts the feed throughout the year is not sufficient to develop the cattle to a condition where they are fat enough to go on the market, but for breeding purposes this land is unexcelled, as indeed is nearly all of the tableland of Mexico.

Chihuahua is the only one of the northern tier of States where anything like winter weather is experienced, but even there the winter losses are said by cattle breeders to average considerably less than 1 per cent. In this State cattle are raised and shipped to the United States as yearlings or two-year-olds, to be fattened until brought to a marketable condition. This plan has now been going on for some years, and is increasing in importance year by year.

Another profitable industry to engage in, in connection with ordinary farming, or as a separate business, is hog raising, for the world-supply is so far behind the demand that the price of bacon is said to have increased 128 per cent. during the last three decades.

In the last three or four years good progress has been made, not only in breeding, but in the maturing of increased numbers of hogs in many sections of the Republic. About 75 per cent. of all the hogs slaughtered are turned into lard, and a large proportion of the remainder is consumed as fresh pork. Competent authorities state that the hog business in Mexico has shown more improvement during the period mentioned than any other single class of live-stock. A considerable percentage of the hogs now grown and marketed here will compare favourably with the average hogs grown and marketed in the United States. The climatic conditions, together with the fact that hogs in Mexico are fed longer and are marketed at a greater age

than in the United States, makes them yield 3 per cent. or 4 per cent. more lard, which causes them to be that much more valuable.

The principal drawback to raising hogs on a large scale is the fact that up to the present time Mexico has not been raising enough grain to feed her people, and because of this the price of corn and other grain is more or less prohibitive so far as hog feed is concerned. However, with the necessary improvements in the methods employed in the enlargement and development of the agricultural resources of Mexico, and the raising of more alfalfa and other grasses which are good hog feed, this situation would be largely overcome, and with every facility for curing and marketing hog products, the future seems bright for intelligent hog raising and fattening in Mexico. Again, were large coco-nut estates to be established, they would offer great possibilities for the industry, given the foodstuffs and the room. There is a steady and stable market for all hogs offered for sale, and the demand will increase for many years and be sufficient to hold prices up, so that the business, intelligently conducted, should be very remunerative.

Some object to the very name of hog or pig on a coco-nut estate, on account of the trouble given and damage done by wild ones. "Among the enemies of the coco-nut tree," wrote a Ceylon planter, "the wild pig has the first place, not only because he is the most destructive,

but because he is the earliest enemy the young plant has to contend against. The white ant comes next." Those raising hogs for market, however, not only must keep them fenced or hurdled in to avoid damage to young trees, but also because they would otherwise tend to stray and be lost, and more especially

LEAN PIGS ON A MEXICAN ESTATE.
(Probably belonging to Obispo Company. Note the "live" hedge on the left).

because a roaming pig yields but a poor meal. You want to fatten up and dispose of the animals as speedily as possible, so they must be penned up about the estate between the fully grown palms and moved on as often as possible to manure the soil, and to have clean ground

under them. On no account must pigs be allowed to roam about the estate; there is only one animal more destructive than they are, and that is a goat. What a goat will do during a Sunday morning stroll in a tropical town or village when the public are absent from the streets does not bear being thought about, and a pig among young cultivations is not much better.

Regarding the distance at which the palms should be planted (and consequently the area available for grazing), the following extract from the *Agricultural Journal*, of Queensland, shows that the roots even more than the leaves must at times be taken into consideration; for whilst the leaves might be satisfied with 30 ft. or 36 ft., the roots cause some planters to set the palms 40 ft. each way. "In view of the divergence of opinion as to the distance apart at which coco-nuts should be planted in order to secure the best results, H. E. Sir William MacGregor requested Mr. T. A. Williams, of Sabai Island, Torres Strait, to furnish him some information on the subject of the diameter of space to which root cords spread out from the base of coco-nut trees, and from the measurements made by Mr. Williams it was found that one cord stretched 50 ft. from the base of the tree. This tree was, however, planted at the edge of high-water mark, the root cords exten-ing along at right angles in soft, sandy loam."

CLEARING AND PREPARING THE LAND.

Broadly speaking, there are three varieties of land which come under the consideration of the coco-nut planter when laying out his estate: (1) Grass land; (2) secondary jungle; and (3) virgin forest. The first is naturally the easiest to clear and prepare. It consists as a rule of old abandoned cultivations, and in this case it should be ascertained what the reasons were for deserting it. It often happens that the natives indulge in shifting cultivations; they do not stick to one piece of ground, but move on after a year or two to fresh ground. They do not understand the art of fertilizing by means of manures, and their exhausting cultivations therefore force them to shift their fields. It can be seen by the state of the growth of the scrub whether the land has lain fallow long enough to regain its fertility. In the Tropics the decomposition of the herbage and refuse takes place very rapidly, and these give back to the soil most of their nutriment and fertile qualities. Big stretches of lalang or elephant grass should be eschewed. It is a most stubborn thing to eradicate, the roots being very wide-spreading and deep, and if even a

little piece is left in the ground it will bring forth new tussocks and spread again rapidly and persistently. This is not all, for the bacteria and exudations from the rotting roots are most inimical and detrimental to the roots of the coco-nut trees that chance to come in contact with them. Such land entails a great deal of expense in getting it perfectly and definitely clear of the lalang (cogon) grass and, if it occurs, the only radical way of dealing with it effectively is to plough it up as deep as possible with power machinery. This, however, is seldom possible, especially with beginners. Another sore trial on otherwise good coco-nut lands in many sections are the wild palms of the pandanus variety, the dum-palm, the ordinary pandanus, and the mkoma. Their roots form a perfect network for many yards round and run along close under the surface, throwing up fresh clumps of trees as they go. Their vitality is marvellous, and after lying dormant several seasons they will suddenly reappear with fresh vigour. Constant attention is therefore necessary to eradicate these as well as the elephant grass.

In comparison with the above, secondary jungle land is an easier task, but in this case the drawback is the multitude of roots of the scrub and trees which has to be dealt with in an efficient and thorough manner, or one will have continual and never-ending bother with the recrudescence of them, especially in the wet seasons.

It is, and always must be, a *sine quâ non* that all clearing work be done properly at the start. Neglect in this respect will bring in its train all sorts of trouble later, chief among which are rot and fungus, white ants, and other insect pests.

The third case, that of virgin forest land, is of course the hardest and most difficult, but such land when once cleared is also generally the best all round, for it has never been impoverished by crops, and retains all its original features of fertility and freshness.

Some people after the forest is burnt off recommend the getting of a crop of legumes or maize off it for a start in order to make it more tractable and fit for the planting of coco-nut trees.

When laying out an estate it is the practice in some centres to carry out the clearing operations by contract labour among the villagers in the neighbourhood. This is an excellent and speedy way where all conditions are favourable, especially if the men work on the American "bee" system, *i.e.*, all help the one man you employ, then he and others go elsewhere and work under another (your task being completed) who has secured a similar "job." This plan has the great advantage that you have to haggle with only one man, who in his turn gets far more out of his fellow-workers than ever you will.

Beginners can as a rule be guided by local

customs and methods of payment, so long as they take care not to be misguided by the rogues and never-works who abound in the Tropics as they do over here.

In cases where the clearing must be done by outside labour, which has to be brought in numbers to the spot, it is necessary from the very beginning to arrange for their proper housing and feeding. And these Coolie lines, as they are called, must be so located that they do not interfere with the planting area. A supply of good wholesome water is a prime necessity, and the buildings must be constructed with every regard to modern sanitary ideas, and afford perfect protection against the weather. The planter's interest also demands an efficient and well-stocked medical store, with a full line of drugs and appliances on the spot, ready to deal instantly with any emergency or outbreaks of sickness, so common and swift in the Tropics, and to attend to the manifold injuries which are bound to happen where sharp instruments are used and heavy timber handled.

Timely provision and preparedness for sudden emergencies and accidents is a mainstay not to be despised. Often there is not time to send for a doctor, perhaps a day's journey or more, should cholera or plague or small-pox break out in the lines, or if half a dozen men should be suddenly brought in seriously injured by a fallen tree. All these

COCO-NUTS TWO YEARS OLD ON THE CIE. DU BOROR'S "TOMODO ESTATE," ZAMBEZIA, SHOWING PORTION OF A ROAD, OR AVENUE, TWELVE MILES LONG.

visitations are likely to occur at any moment, hence forethought to attend to them is absolutely necessary. A good medicine chest and an able, qualified native medico have more than once saved the situation in a panic and with cases of distress. The wise expenditure of a moderate sum in these necessities is well spent, indeed. To prevent epidemics, it is advisable to drain the labourers' lines well, and keep a good stock of reliable disinfectants for flushing the drains regularly and for spraying the insides of the houses. One other most important item is the proper and wholesome feeding of the people under one's charge. It pays every time. The dusky brethren are, after all, human, and respond gratefully to decent, if firm, treatment and the just management of them, although, unfortunately, many unthinking persons deny this and claim that harshness and severity are necessary in order to obtain the utmost value out of their labour. This is, however, by no means borne out by facts. The worthies who advocate such measures are most frequently to be found in the big hostelries, as near to the bar as their meagre pockets allow, and there they hold forth volubly to the delectation of all and sundry who may be willing to listen to them. The discovery of their career and pedigree will soon reveal the fact that they are like unto the proverbial rolling stone, shifting ever—and no time to collect any

moss or wisdom. On the other hand, indecision and willingness to overlook culpable carelessness and slackness will never do. Use the velvet glove, but let the grip, if kindly, still be sure and firm. With further reference to the feeding of the men, care must be taken to provide such foods only as they are used to. Prejudice in this respect is manifold and varied and must be respected. In the first place, the men will not thrive on food they are not used to, and all sorts of disturbances and dissatisfaction will arise if they are forced to eat it. It is no use whatever to offer maize or flour to a rice-eating race of people, nor a meat diet to vegetarians; meat causes diarrhœa to those who seldom if ever eat it, and should certainly be avoided. Having found out the exact standard dietary of the natives, let it by all means be given to them of good, clean and sound description; the small extra price incurred stands in no ratio to the trouble and bickerings which will be avoided, whilst ill-will, desertion and strikes will be prevented. For be it noted that the strike-microbe has penetrated to and spread over the uttermost confines of the Far East, and whether it takes the form of passive resistance or open riot the trouble is none the less trying to those needing the labour.

All clearing work should be taken in hand towards the end of the big rains, in order to give the felled wood the maximum of a dry

spell to die off and be fit to burn. According to the denseness of the big tree trunks, and the paucity or otherwise of the lesser ones and undergrowth, the labourers, divided into squads, are provided with axes, bush-knives and mattocks. Always bear in mind that in the Tropics the labourers, taken as a whole, lack the strength and stamina of the meat-eating dwellers of temperate countries, and therefore the make of the tools chosen for them must invariably be of a lighter pattern, and, wherever feasible, the shapes they are mostly used to should be studied. The men with the matchets or bush-knives occupy the van and cut down all the growth up to about the thickness of an arm. They also cut and remove it in such shape that the axe-men can follow and tackle the big trees without hindrance. After a few days' work a way will be found for dividing the various tasks to the best advantage of all, so that with the various sections of men, one lot does not hinder or overlap another. The axe-men fell the trees as close as possible to the ground. They also cut up the logs, branches and boughs into handy sizes for shifting to the piles for burning. A goodly gang of stump-extractors should be kept busy at the same time, in order also to get ahead as much as possible with this important work. This gang of extractors is entrusted with the task of piling the *débris* for the holocaust of

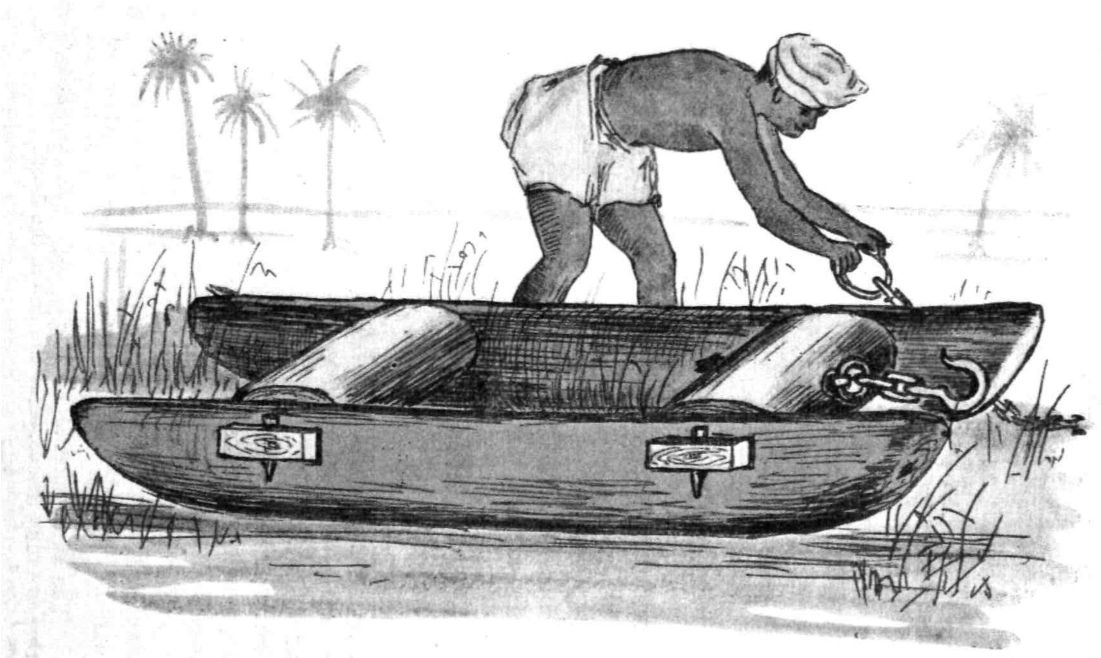
the forest primeval, which takes place at the last after the whole mass has been weltering under the fierce sun's heat for several days, weeks, or perhaps even for months on end. If one takes advantage of the most frequent direction of the prevailing wind, this task can generally be accomplished with great thoroughness and speed, but considerable experience is requisite to build up the heaps if a complete "burn-out" is to ensue. The piles are made in rows and cross-rows conformably with the wind's direction, so that the flames find fresh food for destruction as they are fanned onward by the breeze. If the piles are built with ingenuity and the material disposed according to its inflammability from top to bottom, the result will be most satisfactory. A few general instructions are nearly always sufficient to make the natives realize what is required, and there are frequently found among them some who have already done such work before, either on their own account or for planters. In any case, the most inflammable material should be put on the ground and the hard damp trunks at the top or in the centre.

There are at present on the market some very effective stump extracting machines, of American and Australian make. They are not expensive and their use is greatly to be recommended. Some are worked by hand, but the more powerful ones

have stout gearing suitable for being worked by teams of oxen or the like. Their judicious use will be found of very great help where a specially clean job is aimed at from the beginning; and this is always the best policy. For hand work especially, the Australian "monkey-jack" can do "a power of work" in comparison to its cost. One will get the utmost out of these where expert European supervision and direction are available, and in more troublesome cases dynamite can be used with great effect and benefit, as it shatters large and unwieldy logs and stumps and so materially facilitates their subsequent removal, whilst the smaller roots are blown clean out of the ground.[1] It is highly prejudicial to leave any trees whatsoever standing. For it is a well-known fact that the giants of dense primeval forests are not capable of much resistance when left standing isolated, but are liable to fall with the first strong wind or through decay. In this condition they would consequently be a constant menace to the growing cultivations in their vicinity, and in falling, caused by some high wind, are certain to damage and destroy many pounds' worth of coco-nut trees.

After the first great burn, for which a dry day with a high wind should be chosen, it will be found that a considerable number of

[1] The advantages of the use of explosives in agriculture are fully discussed at the end of the book.



Stone-boats for Transporting Heavy Timber, &c., on Estates.

stumps and logs have still to be got rid of. This is accomplished in the general clean-up which is now inaugurated. What logs remain are still further broken up and reduced in size, then piled with brushwood over the tops of the refractory stumps still standing, and upon these piles are also thrown all the remaining refuse and *débris* that it is desired to get rid of. In fact, these final fires are kept going until the whole clean-up is satisfactorily finished. Draught animals may be used with great advantage to haul good timber logs off the area being cleared. What we call "stone-boats" may also be easily constructed out of the handy timber and used with bullocks for hauling wood and stumps.

"Stone-boats" are made from two longitudinal runners formed of logs about 6 ft. to 8 ft. long and 8 in. in diameter, either bent up naturally at the ends or suitably trimmed for the purpose; these are fastened together transversely, about 2½ ft. apart, by short, stout pieces being mortised in between them. The whole forms a strong platform upon which, being so close to the ground, great weights can be levered with little effort, and when laden they glide easily over the dry ground like sledges. They are further very useful where quarry stone has to be hauled for building purposes, or heavy pieces of machinery for an oil factory, or, in fact, to shift any heavy and bulky thing. While the

gangs of men are still busy with the cleaning-up operation the drainage question should be taken in hand. The system of drainage to be adopted must be well thought out and expertly conducted. In the majority of cases drainage ditches may not be necessary at all unless very heavy rain-water has to be run off from hill land. Where the ground is sloping and undulating they would serve no purpose, except opening up the ground here and there for testing purposes, and to act as ventilating channels. But where the surface is very level and given to depressions, or where violent discharges of rain occur from time to time and the water must be conducted through the estate, it will be necessary to have facilities to drain it off as quickly as it comes, so that it may not form standing, stagnant pools of long duration, or, worse still, flow over the land and wash down the trees, or break up the ground and carry off valuable surface soil and humus. These floods occur often in the Cochin and Aleppi region of India and in the Southern Coast district of Ceylon. In such places, therefore, all the superfluous water is led by means of ingenious canals into lakes, where it stands confined and away out of reach of the palm cultivations until such time as it is wanted.

THE SEED-NUTS.

THE selection of the seed-nuts is a subject to which usually not half enough serious attention is paid. The intending planter should never for one moment lose sight of the fact that upon the proper and careful choice of his seed-nuts almost solely depends the later appearance, well-being and productiveness of his venture.

In the first place, it is by no means sufficient for the planter to purchase the exact number of seed-nuts required to plant up the estate; at least 20 per cent., and some advise 50 per cent., more nuts should be laid down in the nurseries than are required for planting up in the open. To save time the owner, while he is selecting and probing his land, and is occupied with clearing and preparing the ground for planting, should also be studiously looking about in the neighbourhood, or further afield, for what he wants exactly in the way of seed-nuts, and to take nothing less than the best. After careful investigation in the surrounding or adjacent properties, he will find trees, or groups of trees, which yield a greater number and better nuts than the others near them; and whilst the size of the nuts alone is no

criterion those trees that bear well and give bold, even nuts should be selected, and the seed-nuts from them planted. It is to be borne in mind that there is a good deal of individuality in different trees, much more than would appear on the surface, and what exactly constitutes a good tree it is difficult to say; yet while it cannot be predicted with absolute certainty that the nut from a good tree will exactly reproduce its good quality, it can be assumed with a fair amount of faith that a good nut will produce a good tree, which the carelessly chosen seed will only do by chance. It should always be borne in mind that roundish nuts with a full-looking skin, without grooves or too marked an elongation or protuberance at the end, are invariably the best, and that exceptional size is not so much to be desired, as it will generally be found that this quality is mainly made up of husk at the expense of the nut and the meat contained therein.

With regard to colour there are reddish nuts, whilst others are green, and some are of a yellowish hue. The greenish nuts are predisposed to take odd shapes and to contain the least meat; but even here there is a deal of divergence owing to locality, and the only safeguards are actual tests made on the spot. Having an eye to the cheap and safe transport of the nuts, it is well, as a rule, when purchasing seed-nuts, to select a plantation which is as close to hand as possible. If there is

more than one estate to choose from, then go to that one on which the soil most closely resembles the conditions of soil and other items on your own lands, and where the estate generally presents, on casual view, the best and most flourishing appearance.

Of further use is the observance of the number and size of the fruit bundles in the palms. It will also pay to have an eye to the copra-sheds or places where the making of this commodity is carried on. When a locality is notoriously infested with "rhinoceros" or boring beetles, "*Rhynchophorus ferrugineus*" (a small black beetle with long proboscis), rats, squirrels or white ants, it is advisable to be doubly careful. Never buy from such an estate if you can do as well elsewhere. We fully discuss these pests and the means of combating them in another section.

The best seed-nuts come from palms which are in the prime of their condition, say from the twelfth to the twentieth year of age, which is the period of highest vitality of the coco-nut palm tree. Although the actual life of the tree exceeds in many instances half a century, and while they bear their fullest capacity long after the ages given for seed plucking, this fact is so well established by long experience and practice that it would not be judicious to depart from it. With a little care and practice it is not difficult to acquire the knack of distinguishing the more suitable trees from

the older or younger ones. In all cases a sure sign is the bark and, to a lesser extent, the height. A young tree always has a lush, fresh appearance, the trunk appears in full sap as it were, and the bark has not the dead grey look of the older trees perhaps with a growth of moss upon them. The bark is still also heavily scored by the scars left where the leaves have been attached to the trunk and later fallen off. In young trees these alternately disposed marks around the trunk are quite distinct and sharply defined, whilst in the older ones they heal over and disappear gradually as the trunk of the tree grows taller. It is naturally of the greatest importance that the selected nuts for seed purposes should be perfectly mature when taken from the tree. The natives become very expert in determining this, they tap the nut with their finger nail, and a clear, high tone indicates that a nut is mature, whilst a dull, hollow sound tells that it is still more or less undeveloped and green. A little notice and attention will soon make the planter an expert in this respect also. A good many people have suggested that in order to ensure the nuts being ripe, they should be allowed, the same as when making copra, to drop, and that no others be used but those that are picked up from the ground. Against this policy we would say always buy seed-nuts taken from the tree by hand, see that they aro lowered to the ground even and not thrown

down, for the latter process is apt to result in cracking some of the kernels, which must not be allowed to happen, for a cracked kernel is no use at all for successful propagation, and as it can only be found out after many months whether the kernel is sound or not, it is clear that one should be careful in this respect, or otherwise all the labour expended in obtaining, paying for, and setting out the nuts would be in vain.

In almost all cases, where one desires to take selected nuts from the trees, it will be found that the owners want higher prices. This slightly increased cost is, however, in no ratio to the obvious advantages derived from such a course, and the additional outlay should be cheerfully borne. If the seed-nuts have to be picked from heaps, it is as well, if you get the chance, to open some of the various sizes and grades, so as to arrive at an estimate regarding the best interior qualities. After having satisfied oneself in this respect, one can then pick out all those nuts from the heap under offer which contain the largest and most meaty kernels irrespective of the outer husks. It will be found that the interior of the nuts runs fairly even according to the outside. If you find a lot of medium-sized nuts with a large kernel and small husk of a certain appearance on casually looking over the heap, then try to get all, or nearly all, of a similar appearance among your purchases. If for any reason a

nut looks dubious at all, reject it every time, or the benefit of the doubt is always best on your own side.

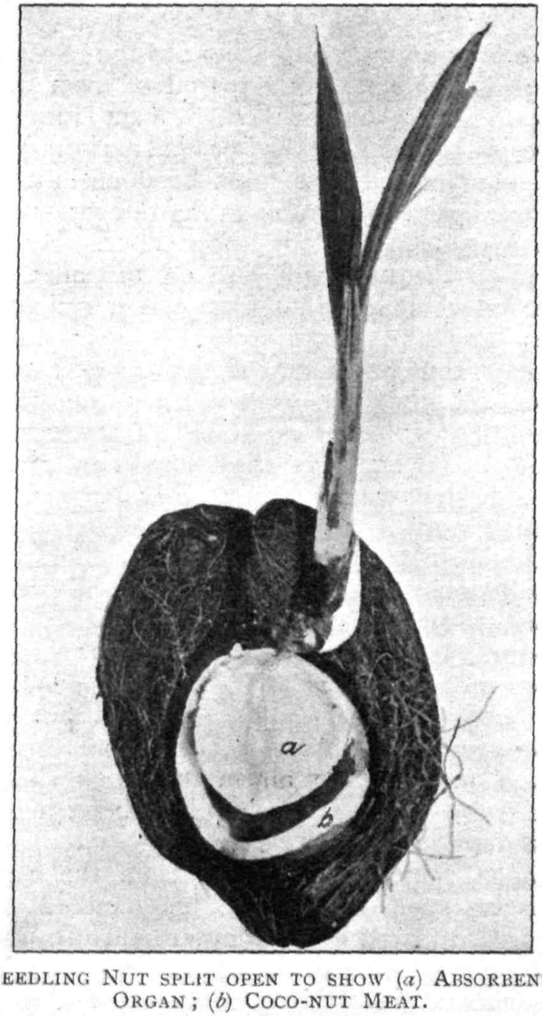
Whilst everyone has heard of the fame of the San Blas nuts, few are certain where San Blas is (most of our inquiries have located the centre in the Philippines, but none of them in Panama, where it is to be found), and so are unable to address themselves to possible sellers of seed-nuts to improve their local supplies. Like the well-known though less famous cocals in the West Indian island of Trinidad, the San Blas nuts come from the sea-shore of what is known as the San Blas coast of Panama. From this centre the United States alone, according to the *Pan-American Bulletin*, take some 6,000,000 nuts, which, up to 1911, sold on the New York market, where the nuts are reckoned as being the finest in the world, at prices ranging from $33 to $48 ($1 = 4s. 2d.) per thousand.

Buy at least 20 per cent. more nuts than you require, and make room for such a quantity in your nursery beds. A certain percentage is always lost from various reasons; some are found after closer inspection not to be all that is desired, others are eaten up by insects and vermin, a good many are damaged in the removal and have to be left aside, whilst others, again, do not germinate properly. Also a stock of surplus plants will be necessary later on for filling vacancies caused by various

We may draw attention here to the necessity of curing the nuts for a period of from three to four weeks before laying them into the nurseries. This "curing" or final maturing and hardening of the nuts must be done in a dry, sheltered place, preferably in a go-down or shed with a trodden mud or adobe floor. By this operation the nuts will lose all the milk still in them which goes to form the germinating cores, and the husks will lose their watery contents, thus lessening the chances of rotting. When the nuts are shaken after the period stated they will emit no sound of water being inside, but if they do, they should be put on one side and used for any other purpose but planting out.

After being thus cured, the husk should have lost all signs of the original colour, and present a dry, brownish hue, no longer heavy with moisture, but light and tindery to the touch. When the nuts have arrived at this condition they may be safely taken out and put into the nurseries. An experienced hand can tell by the smell of the air in the shed whether a desirable state of curing has been accomplished or not.

When removing the nuts from the curing shed or spot, they must be handled with the greatest care, for if they are thrown about violently, or allowed to be handled roughly, the delicate germinating cores are apt to get loosened from their hold in the top-end of the



SEEDLING NUT SPLIT OPEN TO SHOW (*a*) ABSORBENT ORGAN; (*b*) COCO-NUT MEAT.

(For explanation, see p. 181.)

kernel just under the germinating holes, whence the rootlets issue (*see* illustration on p. 180); and the damage resulting is apt to interfere seriously with vigorous growth, if not to stop it altogether.

This germination core is the vital spot *par excellence* in the coco-nut. Most frequently it is heart-shaped, and fills the bulk of the cavity left by the milk in the interior of the kernel. It is buff colour, of a cellular spongy consistency, and emits a pleasant, sweet odour like a flower. It is considered a great delicacy not only by human, but, unfortunately, by a good many insect pests as well. Access to it is easily obtained by boring beetles through the rotten husks, and inside of this through the germination holes, which are provided to the number of three or four in the top of the kernel-shell. These holes are about the size of a threepenny bit, or rather smaller, and closed with a parchment-like lid, which is easily penetrated by the point of a

Reference to p. 180 will show an illustration depicting the absorbent organ of the coco-nut which consists entirely of a spongy tissue, and by the time the coco-nut is well sprouted, completely or almost fills the entire nut. In it are enzymes which convert the insoluble food material in the coco-nut meat into soluble material for the use of the growing plant. This organ is in actual contact with the meat, at least in the upper end, and thus is able to conduct the converted material directly into the young shoots. (Reproduced from "The History and Cause of the Coco-nut Bud-rot," by John R. Johnston). We also show some split nuts in the Manure section. These are copied from groups of nuts in Professor Preuss's "Die Kokospalme." Our readers should study the originals.

knife, and much more readily still by the sharp mandibles of the boring beetles. We may, of course, dismiss with a smile the fables of the clever monkeys who are said to play such havoc in the plantations by climbing the trees and throwing down the nuts in vast numbers, even on to the heads of the people set to watch them. It is true that where monkeys are numerous they do a certain amount of damage, but they do not harm the full-grown nuts so much as they do the flower spathes and embryo nuts. There is also the coco-nut cat, a cat-like animal which climbs trees with facility. It is principally found in Ceylon and the Malay Islands, and does a deal of harm if left to increase to any extent.

The best way to move the seed-nuts about is on stretchers carried by two men on bamboos. This allows of gentle handling from the sheds to the nurseries. The mode practised in some parts of using donkeys and panniers is not to be recommended, owing to the excessive shaking and the frequent spillings of the nuts brought on by the exuberant spirits and general cussedness of these otherwise most useful animals on a plantation. For other work on a coco-nut plantation these hardy little beasts are invaluable. As nut-carriers to the copra-drying centres they have no equal, except in the case of big concerns where field railways and overhead cableways are absolutely necessary.

SEED-BEDS AND NURSERIES.

The first maxim for this important stage in the proceedings is to have ample room on a good, decent and carefully prepared soil. The second essential is the close proximity of a stream or of wells from which reliable supplies of water can be depended upon when needed. If neither of these is available and water exists underground then wells must be dug, for water will probably be required for irrigation purposes when least expected, and must therefore be provided as liberally as possible for such a contingency. If water is scarce, especially in the subsoil, the estate will run but a poor chance of success. The third consideration necessary in laying out your nurseries is to choose a location as centrally situated as possible, for an eye must be kept to ensure the planting-out of the seedlings with the least amount of handling and consequent root damage. The shorter the distance, therefore, that the seedlings have to be carried the better. The nurseries should be on a very gentle slope, if possible, to encourage good drainage. Also extra care must be taken in the clearing and cleaning of the area set aside for them. All of the trees, stumps, and roots

must absolutely be removed, and it is also equally important to see that all grass and grass-roots should be eradicated. It has been well established that a proximity of bacteria from grass-roots, especially of the lalang or cogon variety, is highly detrimental to the growth of coco-nuts. Fungus emanating from rotting wood or roots is also inimical.

In preparing the land for coco-nut planting Mr. L. C. Brown, Inspector of Coco-nut Plantations, F.M.S., in his Bulletin No. 11, says that for the first year, at least, it is preferable to keep the ground free from weeds, as doing so, among other advantages, causes the trees to come to maturity at an earlier stage, saves money in maintenance, and offers greater facilities for ploughing. He attaches great importance, we are glad to see, to seed selection when laying out an estate. With this we quite agree, and it is for this reason that we call attention to the San Blas nuts elsewhere. Mr. Brown reports that the seed-nuts imported from Penang and Province Wellesley by some of the large coco-nut plantations in the Federated Malay States have done exceedingly well; although he adds that excellent nuts may be obtained from Kuala Selangor, Kuala Langat, and Lower Perak. Seed-nuts, we are told, should be selected from well-matured trees of medium size and age, say twenty-five to thirty years, which show a good yield and large-sized *roundish* nuts, either red,

brown or green; oblong nuts should not be chosen. Care must be taken to ascertain that the seed-nuts are fully ripe and not damaged in any way.

In planting out the seed-nuts in the nurseries prepared for them, they should be buried to half their depth and placed in a slightly oblique position, with the acute end of the nut down-

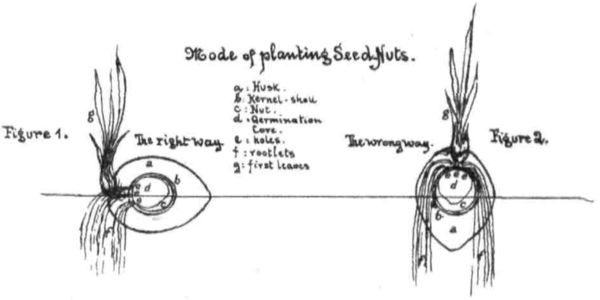


ILLUSTRATION SHOWING THE RIGHT AND WRONG WAY OF PLANTING SEED-NUTS.

According to the latest idea the nut should not be laid perfectly flat as shown; the pointed end should incline slightly downwards.

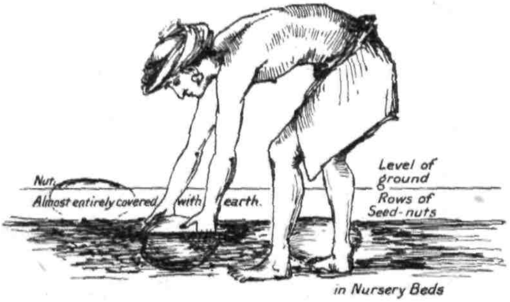
wards. It is an advantage, concludes Mr. Brown, not to plant the seed-nuts for a month or so after they have been picked, so that the outer skin may get thoroughly dry, and the husk be allowed to harden. This is to avoid pests and rotting from dampness. The trees should be planted 30 × 30 ft. (48 to the acre), and when the soil is alluvial and sufficiently above sea-level, Mr. Brown strongly recom-

mends that Robusta coffee be planted 7 × 7 ft. as a catch-crop, at the same time as the coco-nuts. When there is a good local demand for fruit, these can be planted instead of, or as well as, the coffee, but of this more anon.

Where possible, the nurseries should be established in partial shade in order to break the action of the direct rays of the hot midday sun. The natives in Malaya, the Philippines, and some other parts simply form a nursery by collecting a lot of nuts side by side under a heavy shade-tree like the mango or the jak-fruit, and leaving them there until plants, of roughly 2 ft. in height, have grown out of them. It should be so calculated that they arrive at this stage of development at the beginning of the big rains, when planting out into holes dug at the proper spaces is proceeded with. This is not such a bad method after all, especially if a careful selection of nuts has been made. It is possible in this case to select the most vigorous plants from the mass and deal with these only, leaving the weaker-looking ones until the next rains, or, better still, when possible, by rejecting them altogether. Close supervision, again, is in this case a *sine quâ non*, for a small space will contain a great number of nuts. One single "topee" or grove of half-a-dozen full-grown mango trees will in this case be ample to shelter many thousands of seed-nuts, even if the last 10 ft. or so at the outer edge of the foliage crown have been left out of the

reckoning, as being too near the sun's rays. The chief drawback to this proceeding is one's inability to watch the nuts individually—owing to their being so close together—for the depredations of ground vermin, such as white ants, beetles, rats, and squirrels. At all times pathways at every 10 or 15 ft. should be left between the nuts, not only to enable the men to get in among them, but also to see more closely how they are getting on, and if inclined to be attacked by pests. Some people favour the getting ready of the whole plantation at once and planting the nuts directly into the holes—about 30 ft. apart, or 48 to the acre—which have been prepared for them. This is going to the other extreme, for supervision in such a case is well-nigh impossible, Where wild pigs and porcupines abound, such a method, known as planting at stake, is very much to be deprecated, unless the owner is prepared to go to the heavy expense of erecting a game-proof fence of sufficient strength and closeness right around the whole planted area. For a while scrub and boughs, obtained during the clearing operations, would suffice, but such a makeshift would last for less than a year, when it would have become useless through decay (possibly leaving any quantity of pests behind) and the fence would finally have to be put up. We may therefore assume that for all exigencies the now generally adopted method of establishing proper nurseries with the nuts

placed out regularly is far and away the best. In these the nuts are laid out in rows about 4 ft. apart and endways about 2 ft. from each other. Sufficient earth is then thrown over them to cover the nuts and leave a little to spare. In disposing them in this way, there would be 5,445 nuts to the acre, and fifty acres would plant a quarter of a million and so on. This is not too large an area to supervise

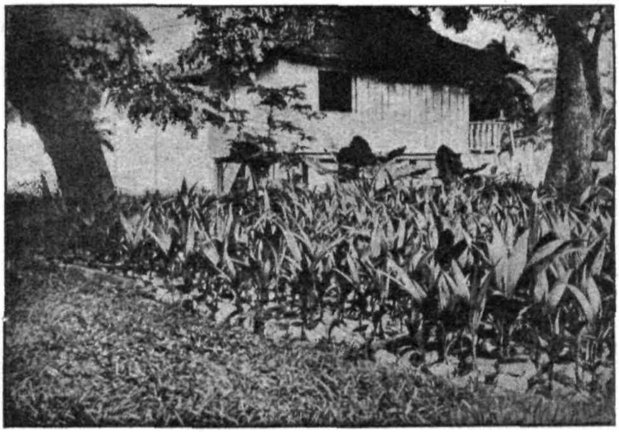


Cooly laying-in Nuts.

properly in one day. In this distribution each individual plant can be carefully watched and developed. All dead-heads can promptly be removed and replaced and new ones set out in their place without loss of time or causing them to show any appreciable difference in size from the others; a gang of men can be set to work weeding or watering, or resetting all the time. Some such plan, when it can be carried out, certainly appeals to us as being better in

all ways to leaving the nuts all hugged up together as shown in the following illustration.

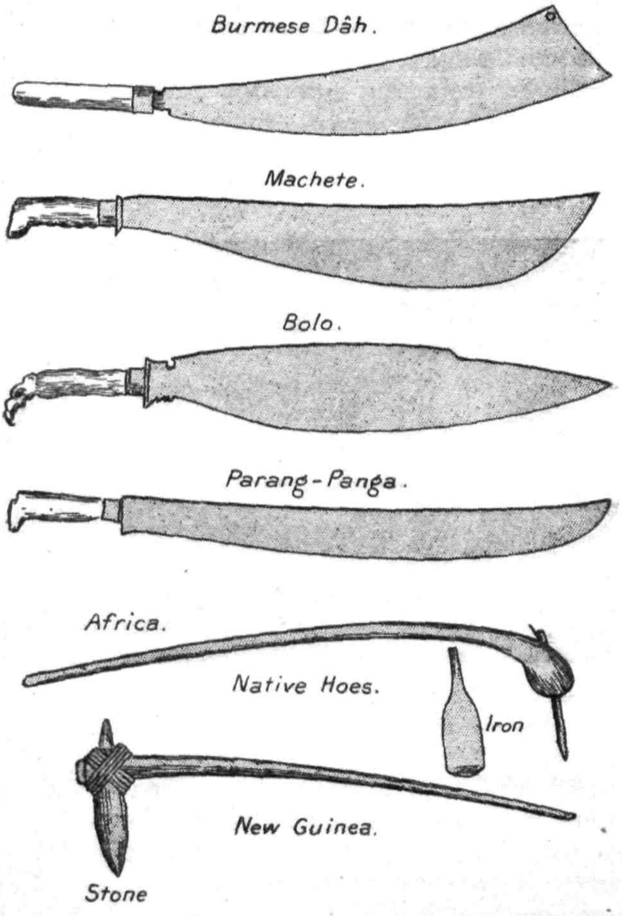
Some people favour the removal of the seedlings from the nurseries into the fields shortly after they have grown to a height of about 18 in. and set up the first bud leaves, whilst others prefer to leave them until they



[*Reproduced by "Tropical Life" from "Coco-nut Growing in the Philippines."*

SPROUTING COCO-NUTS READY TO PLANT.

are about fifteen months old and have set up quite a crown of leaves. In the former case care must be taken to shift them before they arrive at the critical stage, that is when the nutriment in the nut core is exhausted, and before they have had time to set up a "heart" or stem with fronds. This low-vitality period



CUTLASSES, &c., USED BY NATIVES IN VARIOUS COCO-NUT PRODUCING CENTRES.

sets in about the conclusion of the first six months in the nursery and lasts from then onwards for another good seven to nine months. If, however, fairly correct calculations have been made at the beginning, regarding the setting in of the big rains, when all transplanting operations should be carried on, it should not be difficult to gauge the operations properly and to avail oneself of the methods that seem to best advantage, as in neither case would an appreciable set-back of growth be the consequence.

The small seedlings have the advantage of being most readily moved without much root-damage. The large ones require correspondingly more care, but if gently and well handled they have the advantage of great vigour and immunity from enemies in the open plantation.

All removals must be made with sharp, suitable instruments, such as a keen-edged broad spade or with "parangs" or native cutlasses ("dah" in Burmah, "bolo" in the Philippines, "panga" in Africa). The aborigines are very skilled in the use of these instruments and with them may generally be depended on to do the necessary work with least damage to the roots. The first category, *i.e.*, young seedlings, may lose quite a lot of roots without much injury, but in the case of the larger kind, if root damage has taken place, it is well to remove a foot or two of the foliage in order to balance the top and bottom so as to guard

against assault and battery by high winds, while the plant is getting the missing roots back. All plants, on being set out, should be shaded by means of palm leaves set tripod fashion and tied together at their tops.

A SEEDLING COCO-NUT, SHOWING ROOTS AND FOLIAGE.

When removing the seedlings from the nurseries, great care must be taken not to injure the "navel," or that part of the plant where the head comes out from the husk of

the nut, as it is still very tender and only loosely jointed, so that any pulling at the leaf bud will result in breaking the tender joint and injuring the plant permanently. A great deal of damage is done in this way, for the careless native is naturally prone to seize the handiest part, viz., the leaves, in order to aid him in removing the plant from its bed. Personal supervision is here essential, or a serious set-back and unsatisfactory results generally to the growth and vitality of the palms are sure to follow.

In localities where no natural shade is available, it is necessary to build shade-roofs to protect the tender plants from the direct influence of the sun. The more wide spreading these roofs are made, the better, but it is not necessary, as some people advocate, to cover in the entire area, nursery-paths and all. The material for these contrivances is nearly always to be found at a low cost in the immediate neighbourhood. This is where a clump or avenue of bamboos on the estate can come in very useful and save quite substantial bills for uprights, roofings, &c. First of all it requires a large number of stout sticks about 6 ft. long, with a fork on the upper end, so that when they are firmly fixed in the ground, they still stand 4 ft. clear. In order not to make the roofs too unwieldy and cumbersome, these shelters should be made only wide enough to cover in about four rows of plants. Such a

width enables one to use coco-nut leaves with the butt ends lopped off to advantage. The frame-work to carry them over the forks is made of bamboo, or saplings where the former are not available, as on the East Coast of Africa. The whole structure must be high enough to allow men to pass under them to attend to the plants and stiff enough to withstand a strong wind pressure without toppling over and injuring the plants under them. The covering must not be quite impervious to the sun's rays, and it must also allow any rain which may fall to be able to drop freely through on to the plants. Struts can be erected at suitable places to stiffen the whole structure, and white ants, where they are discovered tunnelling up the posts, must be sedulously destroyed.

LAYING-OUT THE PLANTATION, LINING, AND HOLING.

Let us now assume that the area to be planted has been made thoroughly fit and clean for the next process of staking it off for the holes where the young coco-nut plants are going to be finally placed.

By this time a fresh growth of grass and herbage will have made its appearance, for nothing furthers plant-growth more than disturbing the soil. This may be allowed to remain, it will prevent the drying out of the top-soil, only men should go over it with slashers and hew down the long shoots.

All this will decompose on the spot, and go to form new sources of nutriment, besides acting as a mulch. The ashes where the timber and scrub have been burnt should remain undisturbed until needed for mixing with the earth for refilling the holes after the seedlings have been planted out. Where big fires have taken place and have burnt the soil of the surface very much, this should be removed or worked up. At the same time care should be taken of this burnt humus, as there is good stuff in it still.

When getting his running-lines and stakes ready for marking-off the positions of the

holes, the planter must make up his mind to be liberal, and allot ample space for each individual palm. The coco-nut tree requires light and air, and lots of it, to grow to the best advantage. The crown of a well-grown mature tree is at least 30 ft. across and should therefore have that much room on the ground also. We would not say that the wide-spreading roots cover quite the same area, but they are certainly over 20 ft. across, and the remaining unoccupied space is all to the good. Base-lines must be made as true and straight as possible. It is just as easy to do so as in the haphazard manner that makes them irregular, whilst nothing looks worse than wobbly lines in a plantation.

The marking-off stakes should be good substantial ones and well rammed home in their exact positions so that the coolies who make the holes will have no difficulty in locating them, or excuse for making out-of-line mistakes. There are two modes of laying-out—rectangular and triangular, generally known as quincunx. The latter gives rather a closer plan with slightly more palms to the acre. Planted in the square, seven trees less per acre are obtained than with the triangular system.

The disadvantages of planting too closely can easily be proved by comparing the yield of a native plantation which is closely and irregularly planted, with a similar one under Euro-

pean auspices where the trees have plenty of room on all sides. It will invariably be found that the native one yields at least one-third less than the latter, one reason being that the leaves rub together, and this friction reduces the yield.

Such high authorities as the Department of Agriculture in the Philippines, and Professors Semler and Preuss, estimate the average yearly yield of a healthy mature coco-nut palm at sixty useful nuts, but against this the native plantations rarely ever show much more than twenty-five nuts for the same period, and it is generally admitted that large, and very large plantations, taken as a whole, work out on an average of forty, or at the very most, fifty nuts to the tree.

The natives are wont to express their wealth and income according to the number of trees they possess, and assess a man's income at so many rupees according to his trees, each tree being supposed to yield one rupee clear profit per annum. In the Straits Settlements the same count goes by dollars, worth 2s. 4d. against 1s. 4d. for a rupee, so the calculation is not a hard and fast fixture to go by.

Before laying-out the plantations, it is essential to decide definitely upon the location of the factory and store-house, as well as of the dwelling-house. The sites for these, for vegetable and flower gardens, for paddocks, and any ornamental or open spaces, must be chosen

and pegged out before any planting is started, at least in the locality of where the buildings are to be. Then sites should be allocated for shipping, &c., if the plantation is near the sea or river, or for junctions and crossings, if a light railway is to be built, especially in a large undertaking, because the roads and avenues of supply must lead radially to this central spot, where the administrative and transport buildings, factories, &c., are to be found, otherwise a miscalculation made in the beginning might lead to inconvenience and extra outlay to rectify matters later on.

Roads should preferably be constructed in a manner that they will form to a great extent the boundaries between the divisions or "fields" of the plantation, and here and there extra wide roads should be left to restrict fires, pests, &c. Any other necessary divisions can be made either by missing out a row of palms, or by planting rows of trees other than coconuts, as with isolation belts, for which purpose the most suitable ones are the Betel or Areca Palm, the Kapok or Silk Cotton tree, and possibly (we would say always when convenient) the Bamboo. The Areca Palm is also eminently fit to be set around the boundaries, as it can be planted very close together, less than 10 ft. apart, and its durable if slender trunk lends itself excellently for the fastening of fencing material upon, whilst the revenue from its nuts, which are so freely

used all over the East for betel chewing, and elsewhere for medicinal and toilet purposes, would be quite an item with such numbers of trees as would be required on a plantation of any appreciable size.

The Kapok tree is a quick grower, and has not much of a crown, which only in exceptional cases would interfere with the foliage of the nearest coco-nut trees. The cotton which it yields from a large number of pods is also worth picking, as the demand for it has greatly increased of late, causing the price to advance first to 3½d., then over 7d. and now to 5d. per lb. Long avenues of these trees could be planted, and would produce quite a useful quantity of cotton, probably amounting to several tons in a year.

The Bamboo, although it will not make a very lasting fence, can make a very useful barrier, and should be always grown when there is room, if only for the thousand and one uses to which it can be put in the daily working of a coco-nut or any other plantation, besides which an avenue or wall of well-planted bamboos is always an ornament and forms an excellent wind-break.

In many localities pine-apples are grown with profit under the coco-nuts; it is often a good plan to grow them in rows as boundaries between fields. The pine-apple is not only a wholesome fruit in universal demand as an article of export, but in a fresh state also for the

order that the soil may settle properly, and if there is the time it is good to leave the open holes undisturbed for a month or so before planting, so that any falling rain during this period may enter. This is an advantage, as doing so further loosens the subsoil and encourages the penetration of light and air, which are always beneficial in any case.

Where the soil is very heavy, it is judicious to add a little sand to the refilling mixture. It may happen that when digging the holes, which should always be dug with the stake as a centre, one comes across big stones or roots of trees which were too deep-seated to be removed whilst clearing operations were going on. All such must now be most scrupulously removed, as the roots of the growing coco-nut tree must have as full and free a scope as possible for spreading and developing.

The size of the holes depends, of course, in a great measure upon the individual plants which are to be set out. The older and bigger they are, the greater must necessarily be the space for their roots laterally, and in a less degree vertically, to develop and spread without hindrance. The most ample holes of all are therefore naturally required for those larger seedlings which go to replace dead-heads, weaklings, and others which have not come on satisfactorily. Some of these may be up to three years old, and should have a hole not less than 6 ft. cube.

After the plants have been set, there should be a couple of hands' breadth space below the level of the ground, which depression serves as a natural reservoir for rainwater to collect in and so irrigate the plant mechanically with every shower.

When the time approaches for transplanting operations to commence, the circumspect planter will have taken measures beforehand to secure as large a working force as possible. This must be aimed at with all resources at one's command, as the big rains only last a certain number of months, sometimes only weeks, so it can readily be understood that despatch is advantageous, especially as the even growth, and through that the even ripening of the plantation as a whole, should be always the first aim, and this cannot be if there is a marked difference between the ages of the palms. When it is understood that one man can only handle about five dozen plants in a day's work, it is easy to realize the labour force necessary to tackle an area of even moderate dimensions.

In this process of transplanting, the closest supervision of the labourers is absolutely necessary in order to see that the least hurt or damage possible is done to the roots or the navel.

The operations must be conducted systematically; thus, the rows of young plants in the nursery should be rendered accessible by

running a ditch along them of such depth as to allow of a sharp spade to be inserted underneath the roots with a little earth to spare. The ground will probably be wet when this takes place, but if it is not, liberal and copious watering a few days beforehand will make it so.

The soil used in well-made nurseries will be found of sufficient tenacity to hang together around the roots when the plant is lifted (by a spade and *never* by the leaves). The lifted plant with the soil attached is then carefully set into a tray, side by side with a dozen or so of others, all according to their size.

The tray should have carrier poles and flap-sides or other arrangement to uphold the plants and prevent them from toppling over. Two men, as a rule, carry the trays into the fields alongside the holes prepared ready for planting. Here the plants are carefully and gently taken out and received by the man who plants them at once. He places each one in turn in its hole, and fills in and presses the earth gently and evenly all around, stamping it down firmly when all is straight and perfect. To ensure the quickest, and, at the same time, the best work being done, the gangs must be broken up into three sets, viz., lifters in the nurseries, traymen or carriers, and planters-out. To do this so that each section shall be kept continuously at work, some little trouble must be taken to see that the right proportion of men is allotted to each task, so that one set is not kept waiting by the others.

It was reckoned that, in Malay, low grass lands would cost \$25 (\$ = 2s. 4d. per acre) to cut, burn off, drain and plant, including the cost of the seed-nuts. The importance of proper drainage was shown by the statement that the cause of some dead trees was probably due to the want of drainage. Experiments in the Philippines have proved that coco-nuts will grow away from the sea, in suitable—*i.e.*, loose, light—soil provided there is ample water in the subsoil, placed there either by natural or artificial means, and that this water is in no wise stagnant, but has the same, or as nearly as possible the same, constant ebb and flow about the roots of the palms that they enjoy along the sea-shore.

Those about to plant coco-nuts who are not satisfied with the size of the local nuts, would do well to get into touch with shippers or planters along the San Blas centre in Panama, or those firms in London who are trying to arrange to supply these seed-nuts, and import a supply of them from that centre, which has not only been noted for its coco-nuts for generations past, but has also, of late, added new plantations which, together with the older ones, are carefully looked after. All who have spoken to us of San Blas nuts describe the centre as being perfectly free of disease, but this we cannot vouch for from personal experience.

CARE AND UPKEEP OF THE PLANTATION.

From the very start, a constant watch must be kept to see that proper care and thorough attention are bestowed on the young trees.

Their welfare and vigorous growth depend mainly in preventing any chance of a set-back, and in keeping their surroundings clear of weeds and scrub, so that plenty of light and air can gain access to them freely, also in carefully watching for, and protecting them from, the ravages of insects and other vermin, and, should the need arise through drought or other circumstances, to aid them, by means of irrigation, fertilizers, &c., to triumph over such natural set-backs as are certain to come now and again. The weeding and cleaning are done by gangs of men appointed specially for this important work, portioned out so many to the acre, the actual number required varying according to the localities and the amount of work to be done through the more or less speedy growth of noxious weeds.

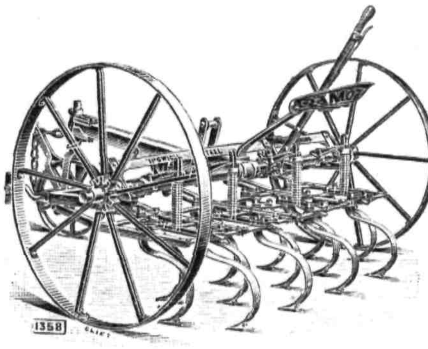
In some places three thorough cleanings per annum will suffice to keep the surface clear and in good order, whilst in other parts nearly twice as many weedings will scarcely be enough

to fulfil the same purpose. Thorough cleaning does not necessarily mean the complete extermination of all herbage appearing above ground, but may include cropping the growth close to the surface so as still to form, with the cuttings, a protective mantle against the drying-up action of the sun's rays whilst reducing the consequent denutrition of the soil from an over-crop of weeds.

Inquiries are constantly being received by us *re* cultivators for coco-nut groves, since we published a review in *Tropical Life* for September, 1911 (pp. 179-180), of Mr. Dean C. Worcester's pamphlet on coco-nuts, so it may not be amiss to include the answers sent out in reply to same, in case others out in the Philippines or elsewhere require similar information.

"Most of the unforested lands," writes Mr. Worcester, "suitable for coco-nuts plants in the Philippines are covered with the tall, coarse grass, known as cogon, or with a species of bamboo grass which closely resembles sugar-cane in appearance, cogon grass being by far the commoner of the two. In order to clean cogon land, the grass must first be burnt off, and the land be ploughed (a strong plough would be needed to withstand the root growth), and then harrowed repeatedly so as to get rid of the roots completely. If this is not done the cogon will promptly re-establish itself. If native ploughs and harrows are used, the land

must be gone over four times the first year, and twice during the succeeding year." To those inquirers who wanted to know which implement could be used for cultivation work under such circumstances we recommended the "Ipswich" steel cultivator as illustrated. These implements are made with 8, 13 or 17 tines. They have *one* steel "through" axle and *one* lever for raising and depressing the



THE "IPSWICH" CULTIVATOR FOR COCO-NUTS.

tines. The wheels are of steel and the centres can be taken out and replaced by new ones, thus making the machine almost equal to new. A swivel-wheel is attached to a short pole, and takes all the weight off the animals, but a pole with whippletrees for either two or three horses, or both, can be fitted if desired. The tines are carried by hinged frames, and are free to follow all irregularities of the soil,

When one end of the reversible steel points is worn they can be turned round and the other end used. The points have ribs on each edge to strengthen them, and require *one* bolt *only* to fix them. Self-sharpening chilled cast points can also be supplied, or steel hoes $5\frac{1}{4}$ in. wide. The patent taper spring steel tines are made of the best spring steel, and are strongest at the upper end, where the strain is greatest, no helpers being now required. The tines are tested to stand the roughest usage, and the pressure is applied through *spiral springs* instead of *flat pressure-bars*, thus giving the tines greater play; the pressure can be varied at pleasure to work shallow or deep, and the spiral springs make the leverage lighter. The tines can be moved sideways, and can be set with more or less pitch. On very foul land some of the tines can be removed to prevent clogging. All the weeds are brought to the surface and killed, and the soil thoroughly aired and sunned by the use of such a machine.

This "mow," as we might call it, is either left to rot by itself, or can be piled into heaps and burnt as soon as it is sufficiently dry to do so. It is not safe to make the heaps too large, because they might flare up high when burning, and damage the fronds of the trees around them. It is never advisable to do the burning-off in a high wind or in the middle of the day, when the stuff is dry as tinder, for then there is a

chance of the fires getting beyond control. In any case, men should be first sent in front to clean a circular space round the boles of the trees with hoes, leaving a circle some 6 ft. in diameter for the young trees quite clean and free from herbage. The diameter of these circles must be gradually widened as the trees increase in size, and may go up to 7 ft. or 8 ft. across. The weeding in each case is best done by the men working with their faces to the trunk, so that the weeds are worked to the outer edge of the circle; they can then be dragged through the outside growth to the heaps and burnt in small lots, without fear of harming the trees (on the contrary, the resultant smoke often suffocates insects or disturbs them, so that they can be caught and killed), or left on the ground as a mulch so long as it does not serve as a nesting place for pests, and so become troublesome. Upon the clear space, the edge of which can easily be raised to keep in the water, is done the watering and manuring, and at the commencement the shading of the roots of the tree by empty husks, &c., or other mulch that you may have available.

The question of labour is always attended with more or less tribulation, difficulties, and unsatisfactory features on most tropical plantations. Many crops such as coffee, cotton, &c., require a large complement of labour at a given time; the cultivation of cotton is

among the worst in this respect. Coco-nuts, on the other hand, have really only one critical period in their growth, on a large plantation at any rate, and that is at the time of setting out the many hundreds of thousands of young plants into the field at the outset of the big rains, when it is imperative to get the work done as quickly and efficiently as possible. During the first three or four years of a coco-nut plantation's existence, there is the incessant weeding to be constantly coped with, requiring a large labour force, and here again, unless the "Goiya"[1] system of Ceylon is in vogue, where the villagers undertake to look after the plantation in return for concessions for growing their food crops on the land, outside labour has often to be recruited, and lodged in buildings prepared for this special purpose. We would again emphasize here, although we have already spoken on the subject, that under no circumstances should this housing be done in a careless and slipshod manner. It pays to run up sanitary, clean houses in a wholesome location, with good wells and free from swamp or dense jungle, which will attract and breed mosquitoes to molest the labourers and bring disease to the European on the place.

[1] The "Goiya" system is similar to the "contract" system in Trinidad and other West Indian Islands, as described in the Ceylon section. For those whose capital is limited, these systems offer good opportunities for reducing the cost of first laying out estates.

COCO-NUTS SIX YEARS OLD ON THE CIE DU BORER'S "BRIGODO ESTATE," ZAMBESIA.
Showing portion of a road or avenue eight miles long.

Each section of such labour forces must be under the properly constituted control of a native overseer, known in various centres as Mandor, Khangani, Nyapara, &c. The sections under the authority of an overseer should never be too numerous, as such a course tends to interfere with proper supervision and authority.

Constant vigilance should be exercised by the white staff throughout the fields, and by the medico in the lines, to see that no injustice or bullying occurs on the part of the overseers towards those under their care.

Some natives, owing to their being physically weak, or of diminutive and puny build, are unfit for general plantation work, but all such have their uses. What Nature deprives them of on the one hand she makes up, say by agility or sharper wits, on the other, and so many of these otherwise unfit can often with advantage be kept for the special purpose of collecting beetles and other pests by hand, and superintending gangs of children doing the same.

It is the task of the man in authority over the whole undertaking, "He who must be obeyed," to vary Rider Haggard, to see that perfect harmony and goodwill prevail at all times among each and every member of the heterogeneous community.

His sense of justice must be of a pronounced kind, and every member must, at all times, feel

certain of being able to obtain a hearing with equal and unqualified justice.

A system of domestic cleanliness must be strictly enforced, for this will in most cases forestall and prevent an outbreak of an epidemic of sickness, and any slackness at the start is liable to lead to trouble in the end. The building and provisioning of adequate hospital accommodation are needed, and a qualified medical practitioner has to be kept on an extensive plantation at all times, in order to deal with cases promptly and efficiently, and provision for a serious outbreak must be always ready. Choose your medico carefully: his ability to diagnose deserving cases, and in sharply pulling up the malingerers, can make much difference in the work done and expenses incurred. In a case where large bodies of labourers for plantation work are alienated for a considerable length of time at a great distance from their homes, it is the wisest course to allow them to bring their families with them, in reason, for it cannot be gainsaid that the domiciling of them in their new surroundings, *en famille*, will be a potent factor of benefit to the plantation itself.

It stands to reason that a man who has his kith and kin with him and is well looked after, and well and fairly treated besides, will, in a vast majority of cases, prefer to stay on and renew his contract, apart from the fact that various members of his family can perform

quite a variety of tasks about the place, such as the lighter field work, weeding, collecting beetles and pests, gathering nuts, looking after cattle, &c.

It has also been found in cases where only males have been brought away from their homes on long contracts, that they become restless and lawless, inclined to interfere with the neighbouring villagers' women and girls, and to give trouble generally. This invariably leads to feuds and serious quarrels, especially among Malay people, whose uncontrollable passions and jealousy are of the fiercest and easy to arouse.

Old stagers can call to mind the experience of some large plantations in Sumatra, where for this reason alone their very existence was being threatened, until the difficulty was partly solved by the introduction of Japanese women. This is now no longer possible, it was a questionable remedy at the best, and tended to lower the moral tone of all concerned; at the same time the trouble that led to the introduction of the Japanese caused a serious crisis in the history of the plantations.

DISEASES OF THE COCO-NUT PALM.

PESTS AND ENEMIES.

GENERALLY speaking, the coco-nut tree, under normal conditions, is comparatively little subject to disease, and the enemies it has to contend with outwardly are few in number, but when they do appear they can do much harm, so must receive speedy attention. Their reduction and extermination is mostly assured by constant attention and by keeping a trained staff employed to look persistently after the palms. There are two or three fungoid diseases which are liable to attack the trees, and of these the worst and most insidious is the "bud-rot." This appears in the heart of the crown of the tree and manifests itself by the turning yellow and withering of the leaves. Once the presence of it has been determined, there seems to be only one remedy, viz., the felling and burning of the tree.

The crown and upper part of the affected tree especially should be burnt without delay. Where this is not expedient, the entire diseased mass must be deeply buried, with the addition, if possible, of quick-lime or other disinfectant.

Care should also be taken to avoid as far as possible any contact with healthy trees, as the fungi are in such cases apt to spread further. Their germs may be carried quite a distance if care is not taken to prevent it; diseased portions therefore must on no account be dragged on the ground, as doing so would spread the disease on all sides. Of other troubles, wild pigs, where they abound, and where large, dense, adjacent forest areas give them secure retreat after their nocturnal raids, are to be dreaded and guarded against, as they are capable of working widespread destruction in a single night. They can destroy whole nurseries of young plants once they get access to the plantation.

The remedy is to hunt them incessantly and relentlessly with hound and gun, and to make strong fences which they cannot break through or crawl under. Laying poison in the shape of yams or rice, &c., impregnated with strychnine or arsenic, will only serve once or twice, and is also to be deprecated because it might reach domestic animals, and even children.

Rats can become a serious nuisance in certain seasons and localities. In the islands of the Indian Ocean, the Seychelles, the Maldives, Madagascar, &c., they have become a perfect plague and do enormous damage each year. They principally attack the embryo fruits, climbing the trees for this purpose.

In order to prevent them from doing this,

strips of tin, something like an open parasol or small umbrella, are nailed round the tree trunks in such a fashion that the lower rim, which is "vandyked," stands out away from the trees so that when the rats run up the tree the projecting spikes and saucer-shaped roof effectually prevent further ascent. To fasten these rat tins round a large number of trees is, however, a tedious and costly job, and in localities near the sea the tin has to be renewed frequently owing to the action of the saline air corroding the tin, so that as the girth of the trees increases they burst and fall off.

A broad ring of coal-tar smeared around the trunks is also a good temporary preventive, whilst rat virus and the various other poisons can be used with profit.

The introduction of the mongoose is to be recommended where there are no serious considerations of preserving eggs and poultry, for if these considerations count, the mongoose is impossible, as where poultry and eggs are, there the mongoose must also be, nothing can keep him away until the mongoose alone remains. Otherwise this animal has so far proved the most implacable foe of the rat, and will seek him out and destroy him just for the sport of it; but like the rabbit in Australia, the mongoose may prove more bother than profit.

Flying foxes and large bats, where they abound, are a source of trouble sometimes, but

they can be driven off with fires and guns should they become a serious nuisance.

Squirrels and a ring-tailed civet cat are in a minor degree responsible for some damage to the young fruit, but they can be taken care of by the staff working around the plantation daily.

Several varieties of large beetles are amongst the most active of destructive agents in a coco-nut plantation, and are fully discussed further on.

First and foremost amongst these is the rhinoceros beetle (*Oryctes rhinoceros*), the female of which likes to lay its eggs in the decaying trunks of palm trees; but as she also lays them in decomposing cattle dung and in compost heaps and tanks it is therefore not safe to leave such things undisturbed for any time without taking precautions to kill the eggs, larvæ, and any insect life found in the compost, otherwise the nuisance will quickly spread to the trees. Insecticides, or even scalding water poured over the heaps, would at least help in this direction.

The rhinoceros beetle is omnivorous in the matter of coco-nuts, it will attack the nuts germinating in the seed-beds, in order to get at the sweet contents contained in their heart, and will bore into young trees or into the heart of the grown ones.

Fortunately the size of the hole it makes enables one to discover its presence with

comparative ease, but if it is once allowed to get the upper hand whole trees soon become perforated, so that in many cases it may be necessary to cut down and completely burn them. Their presence on young leaves may be discovered by the shorn-off appearance of the leaf. The rhinoceros beetles, once they have obtained a foothold in an estate, are very difficult to get rid of, and the remedies need great patience and perseverance. One way is to probe into the holes with a piece of wire provided at the end with a barb like a fish-hook or crochet-hook, and having impaled the insects to jerk them out; another way is by the injection of tar or strong insecticides in their holes to smother or otherwise kill them.

A very good remedy also is the setting out on poles of "bug-lights"; these are made of lighted charcoal placed in baskets, made of hoop-iron, which are then stuck upon poles about the plantation at night time when the beetles are most prone to swarm. Large numbers of them will be attracted to the light, when they can be beaten down by men and boys with brushes, and so caught and killed.

Another insect which, through its potential destructiveness, deserves to be mentioned here, is the *Rhynchophorus ferrugineus*, a small black beetle with a long proboscis. We describe it as a "black beetle" perhaps wrongly. Its colour apparently varies from black to a reddish brown, but the hue is dull

and obscure. This is also a borer and attacks principally the young palms and those which are weakened through some cause, especially those which have already had the attentions of the rhinoceros beetle.

The *Rhynchophorus* is also fond of attacking cracks in a tree, or a wound left by the premature tearing off of a leaf from the trunk, so that needless damage in this way must be avoided.

A tree which is badly attacked by these beetles should also be cut down and burnt, for it is impossible to get at the root of the damage, and it is only a question of time before the attacked tree dies in any case.

In newly-opened ground especially, white ants often become a source of serious annoyance and trouble, as when these pests are present in large numbers the destruction and burning of all the natural vegetation deprives them of their usual food supplies and causes them to turn to the new cultivations. They are very fond of the juice as well as the germs of the nuts, and will bore through the shell to get at them. This sometimes destroys the young plants in thousands, so that arsenic solutions and smoking out of the nests must be resorted to, to rid the estate of them.

A sure preventive for keeping them away is to allow no rubbish or decaying wood about the place, whilst constant hoeing and weeding will also help to rid the place of them.

In all these efforts to combat damage by insects or wild beasts, it is of importance to secure the highest possible degree of co-operation among all the neighbouring planters, otherwise one careless estate will breed and spread disease to the surrounding estates as yet free of any trouble.

Having now discussed pests generally, we will give a few particulars of the chief diseases.

As no one can know everything, at least properly, we are not ashamed to own that our knowledge of coco-nut palm diseases is by no means exhaustive. Even if it ever had been so, such an admission would still be quite excusable, for the close attention and thorough investigation now being devoted to the matter of plant diseases generally, and to the coco-nut palm in particular, is causing, we are glad to say, important facts to come to hand far too quickly for any two men, not giving up their time exclusively to plant diseases, to absorb and thoroughly understand them. Whilst, therefore, we give what notes we can on the matter, we also include elsewhere a list of the more important reports, &c., that have recently been published on the subject. Meanwhile, as in the case of one's home, where *paterfamilias* does not pretend, if he is wise, to be bread-winner, lawyer, doctor, &c., all rolled into one, we strongly recommended any planter who finds mischief brewing on his estate to consult the

nearest plant doctor, and if one is not handy, to send a description of the trouble to the nearest Department of Agriculture, or even the authorities at the headquarters of their respective countries, to try and ascertain from those skilled in the profession what the trouble is and how it can be cured.[1] Might we at the same time mention that such knowledge as is asked for in this way costs much money to possess, and applicants, therefore, when able to do so, should be willing to pay for it in one shape or another. A fee, subscription, donation, &c., either to the individual or institution, sufficient to show willingness to acknowledge the help given, would be but a "fly's flick" in comparison to the cost and loss that a serious outbreak on any estate—coco-nut, rubber, cacao, &c.—is bound to cause the owner. For this reason large estate owners *must* (not should) make arrangements ahead for a plant doctor to be available when needed. Most of the large Eastern tea and rubber estates have done so.

The first book we have always taken down of late when the matter of diseases comes up is Mr. Rorer's report on cacao and coco-nut

[1] Meanwhile planters, or intending planters, would be well advised to secure a copy of Ferguson's "Coco-nut Planter's Manual," which contains very full particulars, culled from all sources up to 1909, regarding pests and remedies. Copies cost 4s. 6d. post free, from *Tropical Life* Publishing Department.

whether caused by bad drainage, careless cultivation, or inferior soil, are the most likely to be attacked by the disease, and therefore improved conditions of cultivation, &c., should render the trees more capable of withstanding attacks. When the disease is found to be established on an estate, immediate and vigorous action must be taken to prevent the disease spreading. Stockdale urges planters "to cut down and destroy all trees showing signs of the disease. If the planter is sure that it is only bud-rot, and that no root disease is present (which is characterized by the disorganized condition of the cortex of the roots, and by the reddish ring of discoloration in the stem), it should be sufficient to cut 4 or 5 ft. off the crown of the diseased trees and bury the top deeply with lime, as it would be found impossible to burn such rotten masses as diseased buds. The remainder, *i.e.*, the trunk and all rubbish, should also be collected and burned, or otherwise these may serve to harbour other pests which eventually may become destructive. The felling and destroying of diseased trees is undoubtedly an expensive process, but the neglect of these precautions may make all the difference between a trifling loss of trees and money and a serious epidemic."

To remedy a lack of cultivation and improve the soil with a view of enabling the trees first to throw off any slight attacks of bud-rot or

other disease, and after that, by keeping the palms vigorous and healthy, to enable them to withstand infection in the future, we would suggest that the following treatment be carried out, as it has proved so successful in Ceylon, where it has been tried :—

Each tree should be manured at least once in every two years. If the manuring can be done once in eighteen months the results will be still more favourable. No grass or weeds should be allowed to grow in the manuring circle round the palms, as otherwise the grass will absorb part of the manure instead of the coco-nuts, and it will be impossible to know for certain what proportion has gone to the palms and what to the weeds.

Every year some basic slag should be spread broadcast throughout the estate, say 1½ cwt. per acre, or 3½ lb. per tree if forty-eight trees to the acre; it should then be ploughed in or dug over and all rubbish and grass buried. These operations should be effected every year, even if basic slag be not used. The more digging that the soil receives the better will be the growth of the palms and the larger the yield of nuts, provided always that there is sufficient water, as the greater the porosity of the soil the more suitable it is for coco-nut cultivation. It is this reason—coupled with the fact that they are (or should be), as a rule, practically saturated with water at a distance of only a few feet below the

surface of the ground—why soils along the sea-front are more suitable for trees like the coco-nut, which require a large, regular supply of water for their growth.

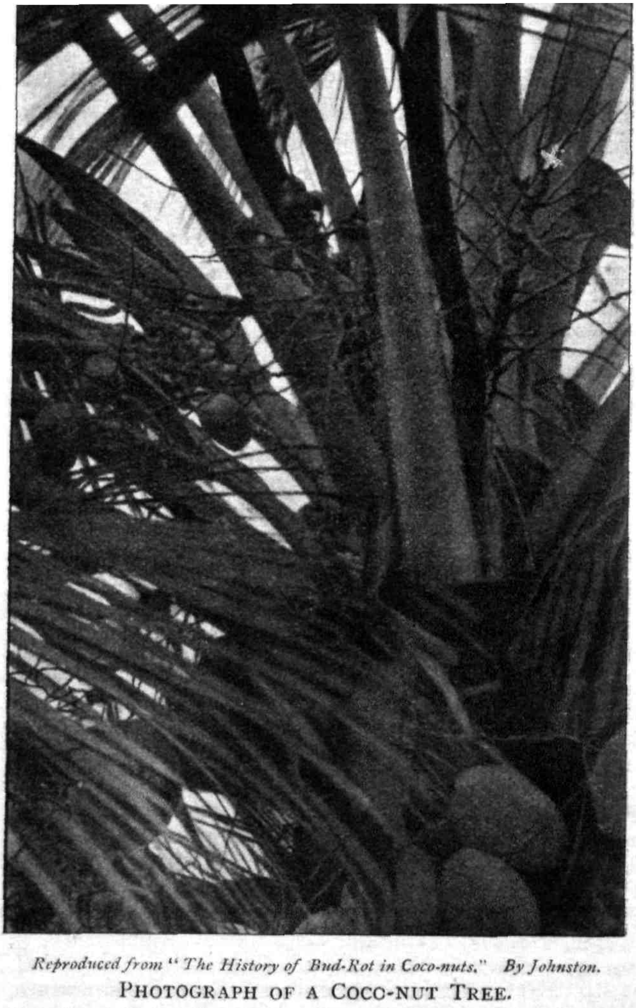
If the land is subject to drought, an application of from 3 to 4 lb. of kainit will help to conserve the moisture in the land, while at the same time acting as a direct manure to the palms. If cattle manure is being collected to be applied to the trees, it is good to also sprinkle kainit daily on the heap in order to prevent the loss of its most valuable properties. Manure thus treated is said to be much richer and its action more rapid and lasting than ordinary cattle dung. It is recommended that all cattle manure be kept under cover, out of the rain, and applied to the palms as soon as possible after being collected.

Since the above was written Rorer reported that the importance of the disease has been somewhat minimized in Trinidad, and that both in Trinidad and Tobago he saw a great deal of bud-rot, which he describes as follows:—

"Bud-rot in its beginning appears as water-soaked areas varying in size from tiny spots to places 7 in. or 8 in. in length at the base of the leaves, spikes or swords, or on the upper part of the trunk itself, spreading into the fibrous and moist 'strainer,' through to the next inner leaf. The progress of the disease in these hard leaf base tissues is slow, but in the soft central leaf tissues it is very rapid."

Johnston[1] says, "How do I know bud-rot at all?............Because I have seen a tree, one of several, bearing twenty-five or thirty healthy green leaves with no appearance of yellowing, and about sixteen spikes containing in all more than 100 nuts, and four or five green swords, but with one spike which had dropped all of its nuts, which were about 2 in. in diameter. The centre of the crown was perfectly healthy. It was determined that the tree was diseased at the base of the one spike which was minus its nuts. The spike with its subtending leaf was removed, but no care was taken to disinfect the adjacent portions of the tree. In two weeks the other spikes began to lose their nuts until the tree had scarcely thirty left. Twenty-one

[1] As quoted by Rorer, who gives the following names and references in his report, as being worthy of study:—Earle, *Journal New York Botanical Garden*, 4, 8, 1903, reprinted in *West Indian Bulletin*, 4, 6, 1904. Dr. Erwin F. Smith, *Science*, N.S., 21, 500, 1905. Hinchley Hart, *Trinidad Bulletin*, 6, 241, 1905. Horne, *Cuban Agricultural Experiment Station*, *Bulletin* No. 15, 1908. Stockdale, *West Indian Bulletin*, vol. ix, 36-81, 1909. Fredholm, *Proceedings Trinidad Agricultural Society*, 9, 159, 1909. Johnston, *Cuba Review*, 6, 23, 1908, Bulletin, Department Agriculture, Trinidad, 9, 25, 1910, United States Department Agriculture, Bureau of Plant Industry, Circular No. 36, 1909, *Phytopathology*, 1, 97, 1911. Rorer, *Bulletin*, Trinidad Department Agriculture, 9, 22, 1910. Circular No. 2, Board of Agriculture, Trinidad, p. 4, 1911. Butler, Agricultural Research Institute, Pusa, Circular No. 9, 1908. Memoirs of the Department of Agriculture, India, Botanical Series, vol. iii, No. 5, 1910.



Reproduced from "The History of Bud-Rot in Coco-nuts." By Johnston.

PHOTOGRAPH OF A COCO-NUT TREE.

Showing at X a spike that having been attacked by disease has lost its nuts, whilst all the other spikes are heavily loaded, and together bear 130 nuts.

leaves were removed, one by one, from this standing tree, and the disease could be plainly seen at the leaf-bases, and at the bases of the spikes which were losing their nuts. In this case the disease had not yet reached the central leaves, but observe that in many cases in which I found the rot to be in the centre, this condition was nearly always preceded by a gradual shedding of the nuts, and the progress of the disease at the base of the leaves. Moreover, in the case of some trees which had healthy central leaves, but whose nuts were gradually falling, I have removed all the lower leaves and spikes up to as high as the lowest healthy-appearing sword, thus leaving three or four green swords, and six or seven upright only half-opened green leaves. I pruned the trees in this way and left just an advancing margin of the rot. This infected the healthy sword, and in the course of a few days it split and a discoloured, wilted flower-spike emerged instead of a healthy white one. I left this diseased flower-spike with the diseased tissues for a week or so, and then removed the spike and subtending leaf, but did not disinfect the adjacent tissues. By a slit into the lowermost remaining sword it was seen to be perfectly healthy. In the course of a week it, too, had turned to a chocolate-brown. Thus, if left, the disease would gradually spread from the outside to the inner and softer tissues of the heart, which succumb rapidly to the disintegrating action."

As already stated badly affected trees must be cut back and burnt, great care being taken not to spread the disease about, if it is necessary to remove the diseased tree to a distance to do so.

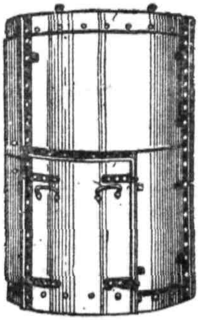
Bulletin No. 70,[1] of the Imperial Department at Barbados, says that by the time the outward symptoms make their appearance, the central bud is usually so badly decayed as to preclude the hope that the tree may be saved. It is far wiser at this stage to cut off the tops of the infected trees, and very carefully remove the diseased parts to where a sufficiently large pit or trench has already been dug, and bury them deeply with lime ; at the same time carefully watch the surrounding trees for the least sign of disease breaking out.

Inexperienced folks will ask why trouble to dig a trench large enough to bury an elephant, as you have to do when several and perhaps a good many palms are attacked and have to be removed and disposed of—why not burn them? The answer will come with experience, but to those who will take our word for it, troublesome as it may be to dig these deep trenches and pits (and deep they must be), then to bring lime to bury in them, such work is still easier than to properly burn and satisfactorily cremate the evil. This need not prevent the trunk and some fairly healthy-looking leaves being

[1] This Bulletin costs only 6d., or perhaps 7d. post free, yet it is well worth stocking amongst more pretentious works.

burned wholly or to some extent; but the rotten bases of the leaves, the damp and often stinking bud, and all infectious material, should be put underground with lime with the greatest possible care and the least waste of time.

Perhaps, however, an apparatus like the one illustrated below might be of use here, for if capable of making charcoal, which is its real use, it should prove effective in rendering harmless, if not in entirely destroying, the infected



portions of the coco-nut palms. One of its advantages lies in the facility with which it can be carted about and placed near to a diseased tree, which can then be cut down, or the top only removed, and the portions straight away placed in the cylinder, where they would be burned or well charred and then buried. The apparatus could then be removed to another spot, and the same process repeated. By this, or similar means, any risk of the infection being distributed could

be averted, for as the stove, charcoal-burner, or whatever else you choose to call the apparatus, can successfully make charcoal from green wood, it certainly should be able to cremate even the most rotten coco-nut bud sufficiently to render it harmless. Being made in several sizes, some as wide as 8 ft. across, the infected parts can easily be packed away inside it, carefully intermixed with dry leaves, trash, wood, &c., to start the fire. The filling is done both through the door at the side, or from the top, the lid being removable. When full it is lighted from the centre vent in the lid, under which some dry litter must be placed for that purpose. Presently, fumes and smoke should issue from the top and bottom, and the burner, now well alight, must be left for about thirty hours (*i.e.*, two days and a night, or two nights and one day) if a complete carbonization is desired, but probably a few hours will prove sufficient to render the contents perfectly harmless for removal. As the apparatus has never been used for anything but ordinary charcoal-making, we cannot say more, but certainly feel that a trial might be made with an apparatus like the one shown, especially as Stockdale, in his report of October, 1906, on "Coco-nut Palm Disease in Trinidad," tells us: "When the trees contain a large amount of sap, and still bear a fair number of green leaves, it is almost impossible to burn them, unless a number are collected and burnt

in a pit after the manner of charcoal fires." A machine 10 ft. by 8 ft. costs in London about £85; smaller sizes costing £55 for 8 by 5, and £40 for 6 by 4. The net weight of the largest incinerator is 17½ cwt., of the 8 by 5, 9½ cwt., and of the 6 by 4, 6 cwt.

Once the estate is well watched, there should be no need of a general clear out, for the whole object is to mark the individual trees directly they show signs of being affected, and not to wait until two or three groups of perhaps half a dozen each have to be condemned and destroyed. Such cases do indeed cost time and trouble, but if they arise, let the trees be seen to, let it be done well, and done at once. Better still, however, keep your eyes open, and do not let such cases occur. One tree at a time will be quite enough. In Trinidad, however, Mr. Rorer tells us, a number of different methods of control for the disease have been suggested from time to time. Work done tends to show, he goes on to say, that sanitary methods help to check the disease to a great extent, but to give the best results these methods should be followed up by spraying.

As Johnston has shown, the infection of bud-rot generally takes place at the bases of the leaves and spathes. If these parts of the palms were covered with a good fungicide and insecticide, infection could not take place. A practice which accomplishes this end prevails to a certain extent in some places, and is said to

have good results. A pound or two of coarse salt is wrapped in a piece of the fibrous portion of the leaf sheath and securely fastened to the youngest leaves. The rains dissolve the salt gradually and carry enough down to the leaf sheaths to act as a disinfectant. Spraying with Bordeaux mixture and arsenate of lead would be a much surer way of accomplishing the same result ; Woburn Bordeaux paste is also good. The spraying of coco-nut trees is not at all an impossible thing to do, and is quite practical. We also discuss this at the end of the book.

As stated at the beginning, these questions of coco-nut diseases, and especially bud-rot, are being so thoroughly studied and followed that we must be excused if we do not pretend to deal exhaustively even with the literature on the subject, much less with the disease itself. As an instance of this we received, whilst preparing the proofs for press, a book on bud-rot disease alone,[1] as large, or almost as large, as this one, were it put up in the same type and size of pages.

Under such circumstances all we can do is to quote the following, and then refer our readers to the Department at Washington for a copy of the bulletin. We found no mention as to price

[1] This is "The History and Cause of the Coco-nut Bud-Rot," by Mr. John R. Johnston (already quoted), Assistant Pathologist, Laboratory of Plant Pathology, United States Department of Agriculture, *Bulletin* No. 228, Bureau of Plant Industry, Washington, D.C., United States of America. No price mentioned.

in any part of the book. Every centre is included, and all the authorities we know of quoted, as well as many whose reports we have not yet received. The notes referred to are from the last two pages (162-163).

In the summary of the book, which, as stated, covers the whole of the coco-nut world apparently, we are told :—

In general, those planters attending to ordinary methods of sanitation in their groves had little trouble with this disease (bud-rot).

The cause of the disease in Eastern Cuba is shown by repeated inoculation experiments to be a bacterial organism, practically identical with *Bacillus coli* (Escherich), Migula.

It is believed that birds and insects are carriers of this disease, but the subject requires further study.[1]

In 1906 the Baracoa coco-nut district, Cuba, was the largest exporter of coco-nuts and coco-nut products to the United States of America ; next came the British island of Trinidad, West Indies. Owing to the disease, however, the area under coco-nuts in Cuba has been greatly restricted, and is now mainly confined to the Baracoa district.

Recommendations for prevention and cure are summed up as follows :—

[1] In face of our suggestion elsewhere that chickens and even pheasants might be bred on coco-nut estates, for profit and to keep down insects, this statement is deserving of attention.

Owing to the widespread distribution of the bud-rot no coco-nut district in the American Tropics is secure from danger of infection. This bud-rot is due to a bacterial organism, which may be distributed from place to place on the green unhusked coco-nuts, and may be carried to healthy trees by insects or other animal life infesting diseased trees.

It is recommended, therefore, to cut down all badly diseased trees, or at least trim the tops and set fire to them. All *débris*, fallen leaves, nuts, &c., should be removed so as to destroy any infected material and any breeding place for insects which might serve to transmit the disease.

These ordinary methods of sanitation, together with proper methods of cultivation, if carried out faithfully by the planters of a whole district, will reduce the loss by this disease to a minimum.

Stem and Stem-bleeding Disease.

Stockdale does not touch on this in his "Fungus Diseases of Coco-nuts," but the Imperial Department of Agriculture at Barbados, in their booklet No. 70, gives it about a page, in which we are told that it is caused by a fungus, *Thielaviopsis paradoxa*, which is also responsible for a rot of pine-apples and a decay of cane-cuttings. Its spread in plant tissues appears to be dependent on the amount

of sugar which the tissues contain. The symptoms, we are told, vary according to the age and nature of the trees attacked. In general, cracks appear in the bark, from which a brown viscid liquid oozes that soon turns black and leaves a dark stain on the bark. On cutting away the cortex near the crack, it is often found that the tissue has decayed and become soft and watery. In some cases the outer layer of tissue falls off, leaving a hole filled with fibres; in other cases spiral cylindrical hollows are formed, running up and down the stem; while in extreme cases the whole tree may be rendered hollow to within 2 ft. or 3 ft. of the terminal bud. This may occur only when a few bleeding patches are visible externally. The disease does not necessarily cause the death of the trees, and its effect on the crop is usually small, at any rate for a time. Its importance lies principally in the fact that trees weakened by the presence of the hollow spaces in their stems are liable to be broken off in a strong wind. It is much more prevalent in wet than in dry weather. Pamphlet No. 70 then suggests as a remedy to cut out the infected tissues and burn all chips. This is best done with a chisel and mallet. Wounds slanting upwards, we are told, should be made in order that water may run off them. When the diseased portions have been cut out, the surfaces of the tissues should be carefully burnt with a torch to dry

them, and the wound should then be dressed with tar—Rorer says hot tar—to prevent the attack of beetles.

This disease is evidently more prevalent in Ceylon, for we have cut many articles and notices of it from the Colombo papers, whereas we seldom hear of it in Trinidad. In the East, however, Petch, among others, has studied it carefully, and Rorer quotes him in his report, but even then devotes only twenty lines to the question of stem-disease, so evidently he did not attach much importance to it.

The disease, according to Petch, was first brought before the notice of the Department of Agriculture in Ceylon in 1903, and from 1906 onward general attention seems to have been devoted to it, as at that time, especially in the district attached to the Katana Agricultural Society, the disease showed signs of giving trouble. In reporting this to headquarters, that Society described it as consisting of:—

(1) Oozing out of the trunk of a rusty or dark-coloured liquid.

(2) Followed by wounds on the trunk.

(3) In about two or three years the skin of the trunk drops out.

(4) The top portion of the tree gradually becomes thin.

(5) To about the depth of 3 ft. or 4 ft. the roots wither—sometimes wholly, sometimes partly.

(6) The tree dies after five or six years, or sooner.

It is important to note that there are no signs of the disease until the liquid oozes out, and when this occurs the internal tissue is already decayed to some extent. Mr. Petch, as a remedy, cut all the affected parts clean out, well burnt the wound with a torch of rag dipped in oil, and then covered it with hot coal-tar. This, he adds, effectually stopped any further advance.

A very bad case reported by Petch in Ceylon occurred on a small island bounded by the Negombo Canal, where surrounding conditions were chronically very damp, for it is described as a marsh, although the whole area was planted up in coco-nut palms. We then get a good description of a bad case. "The diseased trees were stunted, so much so that they resembled cycads. They were covered to a height of 7 ft. or 8 ft. with black patches, caused by exudations of sap from minute cracks in the outer tissue. The upper portion of the stem was usually unaffected. The tissue immediately beneath the crack became discoloured, generally brown at first, and finally black, and this condition spreads internally until the patches from adjacent cracks coalesce. The bud remains sound so long as a section of the stem shows a region of undecayed tissues. Several trees were dug up, and it was found that, as a rule, the roots

were dead on the side affected." Beetles which were at first considered to be the cause of the disease were found to bore into the stem only after the tree was dead. This is mentioned in Watt's "Economic Products of India," where we are told that the beetle caused a dark red juice to ooze from the trunk. A bad case occurred in Java, where a batch of some 5,000 palms were attacked, and 1,000 died, so the disease can give real trouble at times.

Leaf Disease.

With leaf disease it would appear that the leaf, succumbing to the numerous drains upon its resources, falls to the ground before the mycelium has attained the utmost limit of its development; for if a leaf that has fallen on a dry spot be placed in a moist chamber, a multitude of pustules bearing conidia will be produced within forty-eight hours; while if a leaf that has fallen in a damp place, where it is shaded from the effects of the sun, be examined, large numbers of spores can be seen to be given off, thus showing that the mycelium is capable of further growth after the leaflet has fallen to the ground. The spread of the disease appears to be influenced by the age and condition of the plants, and as with the root disease, improved cultural methods are of the highest importance in checking it from spreading, if not in actually curing the disease.

Where the disease, short of the death of the tree,[1] causes the planter considerable loss is by the serious check that it gives to flower development. On account of the disease, less flowers are produced, and finally the diseased condition of the trees becomes marked in the shortness of the crop of nuts. Even if the nuts are there, the restricted food supply checks their development, and reduces their size, and, of course, their marketable value, if they have any market value left.

Investigations show that the best way to avoid leaf disease is to surround the trees by conditions that promote vigour and health so that, if the disease has not already arrived, it can be kept away, and if the palms are attacked they are encouraged and enabled to overcome the trouble to a very great extent. The fungus seems to be weakly parasitic and only capable of doing appreciable damage when the conditions are extremely favourable for its development.

Experiments show that infection takes place by the germination of the spores, the germinal tubes of which pass through the stomata of the leaf, and through wounds

[1] This is brought about by the mycelium from a large number of disease spots spreading throughout the whole of the interior of the leaf, and entirely destroying many of the leaves. When the whole of the leaf-area of the plant is destroyed, the terminal bud falls over, and the tree eventually dies.

of any kind on the leaf surface. No result, however, was obtained when the spores were placed on the upper surface of an uninjured leaf, which may indicate that these germinal tubes are incapable of penetrating the epidermis of the leaf.

In Trinidad it has been noticed that the disease, at present, is doing serious damage only when the condition of the soil and cultivation are unfavourable to healthy plant growth, and, therefore, in order to keep the palms vigorous and healthy, the matter of drainage (allowing a sufficient water supply, of manuring and cultivation generally to be present) cannot be too carefully attended to. With lands below the sea-level, or containing surface water in excess, drains should be cut to carry the surplus water away, and so prevent its becoming sour. Manuring coco-nut lands is of much more importance than most planters seem able or willing to realize. Manuring may not actually cure the disease, but if the right manure is used, and it is properly applied, it may be the means of strengthening the growth of the plant, and the problem of manuring should be solved by the best resources at the command of the estates. We are trying to solve it to the best of our ability coupled with a little outside help.

The best remedy for leaf disease seems to be fire, and great care must be taken not to drag diseased portions over the ground, as

by doing so there is great danger of spreading the disease. All dead trees should be cut down, and the pieces collected carefully together and burnt. All diseased leaves, on otherwise healthy-looking trees, should be cut out and burned, and any leaves showing signs of disease should be completely destroyed by fire, with as little transportation about the estate as possible. Any trees found with diseased leaves must, after these have been removed, be carefully attended to at once. Manure should be given to them, and the soil around them properly tilled, in order to enable them to throw off the attacks of the fungus. If the disease continues to spread, spraying with fungicides would render the spores of the fungus incapable of germination and so tend to check the trouble. Bordeaux mixture would probably be the most economical fungicide, and should be applied by means of a spraying machine with a long hose attached. All trees showing any signs of disease should be sprayed at frequent intervals to prevent germination of the spores.

Evidence as to the fungus (*Pestalozzia palmarum*) which causes the disease was gathered from planters in the West Indies, but, as in the case of root disease, the general opinion was that it was due to the weakness of the plants, produced by setting immature nuts, or to improper soil conditions. It is impossible to believe this, however; otherwise, urges

Mr. Stockdale, one would also have to believe that a large portion of an estate in the Mayaro district (a very important producing centre in Trinidad, W.I.), or isolated patches affected with disease in the Icacos district, had been planted with immature nuts alone, for elsewhere there was not a single diseased tree. From experiments previously mentioned, there can be no doubt as to the fungoid nature of the disease, and measures for combating its ravages are not easy to discuss or to condense into the somewhat small space we can afford, but Mr. Stockdale has gone very fully into it in his report (1906). The remedies suggested are divided into two sections, viz. :—

(1) Those which will destroy or weaken the fungus.

(2) Those which encourage a more vigorous growth of the palm, so as to enable it better to withstand any attacks of the fungus.

Now the spores of the fungus under favourable conditions exist in such numbers that unless they are destroyed it is possible for the disease, given warm, moist, or windy weather, to spread very rapidly. For these reasons all dead trees should be cut down, all the portions carefully collected on the spot where the tree once stood, and the whole burnt. The leaves must not be dragged about, and burning on the spot helps to counteract the spread of any spores by destroying them.

If a few leaves only are diseased, it will

probably be found sufficient to cut down such leaves and burn them on the ground; do not drag them away. The broken tips of the leaves are characteristic of the disease; the tips of the distal leaflets being the first to show its effects, although an examination of an affected leaflet shows that diseased areas are scattered all over its surface. From these distal leaflets, the disease appears to spread gradually to those nearer the stem, and often when all the leaflets on the terminal (2 ft. to 3 ft. of the leaf) have been attacked, and appear in a dry, withered condition, this portion of the leaf breaks down; it rarely falls to the ground, but remains hanging to the healthier portion, and this, according to Stockdale, is very characteristic of the disease. For these reasons it would be advisable to search throughout the estate at frequent intervals for any tree showing the characteristic broken tips of the leaves with the pustules on them, and such trees should be clearly marked and watched, so that any leaves showing signs of the disease can be removed and burnt. Continued attention must be given until the planter feels certain no trouble has been left behind to spread. The trees so affected should, after the leaves have been removed and burnt, be carefully attended to and manured, whilst the soil around should, at the same time, be tilled in order to invigorate the palms and so encourage them to throw off the attacks of the fungus.

If the disease goes on spreading, spraying with fungicides would render the spores of the fungus incapable of germination, and would therefore be effective in keeping the disease in check. The problem remaining to be solved is how frequently it is necessary to spray, and how soon after complete destruction of the spores will a fresh batch be produced on the same leaf. Bordeaux mixture or Bordeaux paste would probably be a good fungicide to use, and for the sake of efficiency and economy a spray pump with a long bamboo lance must be used, though with the tall trees a boy will have to be sent up. Not only should all the palms that show any signs of disease be sprayed frequently, but also any in their immediate neighbourhood, so as to prevent the spores from spreading.

The Bordeaux mixture, says the *West Indian Bulletin*, No. 70, should be applied in the usual way by means of sprayers, the mixture being made up as follows :—

Copper sulphate (bluestone) ...	6 lb.
Unslacked lime	4 ,,
Water	50 gallons

The 6 lb. of bluestone is dissolved in 25 gallons of water in a wooden tub or barrel by tying it in a piece of sacking and hanging it in the water from a stick laid across the top of the barrel. The 4 lb. of freshly-burnt unslacked lime is slowly slacked and made up to 25 gallons in another tub. Next the lime-

wash and the solution of bluestone are slowly poured together into a third tub holding about 50 gallons. When the mixture is complete, stir and place therein a clean, bright knife-blade for a minute. Remove the knife-blade, and if it is still bright the Bordeaux mixture is safe, but if it appears reddish, more lime-wash must be added until the blade does not become discoloured. The mixture must be stirred before use. There are also, however, some very effective proprietary insecticides obtainable ready mixed for use.

But prevention is always better than cure, and it seems that with care leaf disease at least can be kept at a distance. On an estate in the West Indies where the disease appeared, trees growing on light, dry soil seemed to have been the ones attacked, and in such a case manuring and tilth are absolutely necessary; but Rorer tells us that the leaf disease is only to be found on trees in damp situations, and can doubtless be easily controlled by the use of Bordeaux mixture. With regard to the "little leaf" disease, Rorer, on the other hand, says all badly attacked trees should be destroyed. As the name suggests, this trouble causes the crown to come out with small leaves, and they continue to grow smaller and smaller, until eventually the whole crown simply dwindles away. Such cases are exceptional, but when they do occur, the trees—Rorer tells us—seldom outgrow the trouble. As a likely cure,

manuring again should be tried, because it strengthens the plant and causes vigorous growth, followed up by cultivation to give the tree every chance of developing itself. On the latter point Stockdale is very emphatic, when he urges planters to thoroughly cultivate and drain their lands; and as far back as 1889 Mr. Drieberg, in a report he drew up in Ceylon on the matter, summed up as follows: "The consensus of opinion, and notably that based on analysis of soil, tends to prove that those areas where the disease prevails to such an extent as to disquiet the minds of proprietors and lessees, are suffering from an impoverished condition of the soil as far as the successful growth of coco-nuts is concerned; and to cope with the disease the soil must be by every means raised to the requisite standard of fertility."[1]

Root Disease.

According to Mr. Stockdale, reporting on his investigations in the West Indies, three diseases, or at least three principal diseases, that occur in the West Indies are[2]:—

(1) *Root Disease*, investigated in Trinidad, and from specimens received from British Guiana, possibly also in Jamaica. A similar disease is described in Travancore.

[1] Ferguson's "Coco-nut Planter's Manual," p. 37.

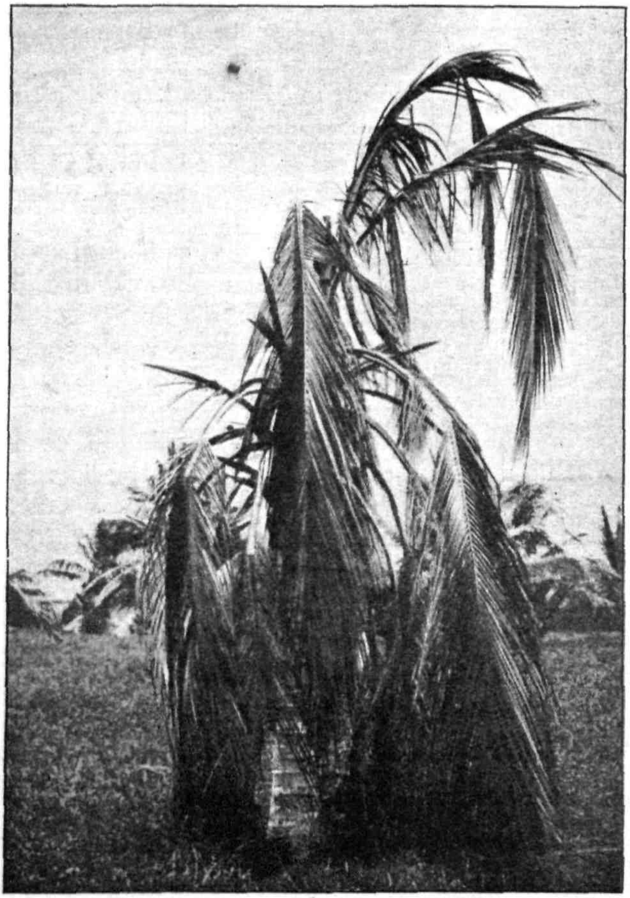
[2] "Fungous Diseases of Coco-nuts," *West Indian Bulletin*, vol. ix, No. 4, pp. 361-381.

(2) *Leaf Disease*, investigated in Trinidad, and apparently very similar to a disease reported from Java.

(3) *Bud-rot*, found in Trinidad, and also doubtless in British Guiana, Jamaica and Cuba. At the last-named centre it is being carefully investigated, as it has occasioned widespread damage.

Trees which only present external signs of disease to the casual observer show that the roots are probably the parts which first become affected. An attack of root disease is generally first shown by the leaves. They show a slightly wilted appearance, then turn yellow, first at the tips and then gradually all over the leaflets. After the yellowing of the leaves, trees bearing a good crop of nuts, as a rule, gradually shed most if not all of them, irrespective of their size and state of maturity, and the flowers subsequently produced do not set.[1] The local conditions of the soil, however, must be considered before a tree can definitely be declared diseased, as its appearance also suggests lack of water; and trees struggling

[1] It is worth noting that none of the books which we have received give any idea as to how long it takes for a nut to come to perfection. We believe that nine months is about the minimum time between pollination and maturity. Eighteen months is the usual time elapsing between the appearance of a leaf and the maturing of the subtending nut. Flowers (on the coconut palm) do not open until more than six months after the first appearance of the subtending leaf.



[*From Circular 4—"Trinidad Mycologist's Report,"* 1911.

COCO-NUT PALM IN TRINIDAD (W.I.), AFFECTED BOTH WITH ROOT DISEASE AND BUD-ROT.

for an existence in drought-affected areas might be mistaken for trees suffering from root disease.

An important point that Mr. Stockdale calls attention to, is that when a coco-nut palm is affected by any disease or pest, the terminal bud in the advanced stages of the disease almost invariably becomes involved in the state of rottenness. This state, however, must not be confused with bud-rot, which is a separate and a specific disease, leaving the roots, stem, and leaves sound, and causing the bud only to become diseased.

Root disease seems to reduce the power of the tree to absorb water, and hence nourishment. Things seem to go fairly well with the trees until they commence to fruit, when, if diseased, the drain on their strength seems too great, and wilting and yellowing follows. It was observed that trees just coming into bearing were the most liable to succumb. In low-lying, undrained hollows the disease was found to be worst, and it is therefore necessary to keep the condition of the soil as good as possible, in order that it may be favourable to the growth and health of the plant. Investigations tend to prove that root disease may spread by means of:—

(1) Mycelium through the soil from root to root, which extend to great lengths.

(2) Spores blown from tree to tree.

(3) Germinating tubes of spores from petioles.

(4) By germinating "chlamydospores" from decaying petioles.

Possible ways, on the other hand, for attacking the disease, and, let us hope for curing it, include :—

(1) Destruction of all diseased material.

(2) Isolation of diseased areas.

(3) Resting and disinfecting infected land before planting "supplies."

(4) Spraying and applications of chemicals.

(5) Improved cultivation and drainage.

(6) Searching for and propagating disease-resistant varieties.

Diseased petioles that have fallen to the ground should be destroyed by burning, as they often bear a large number of spores, which seem able to live on dead matter.

The first symptoms of root trouble are exactly like those exhibited when the palms are suffering from drought; and, in fact, this is the immediate cause of death, for it is lack of water that brings this about, the destruction of the roots preventing them from being able to feed the trees. And on this account one can ascertain whether the palm is suffering from bud-rot or root disease, the first symptoms, as already stated, being somewhat similar. It may be determined whether root disease is actually present or not by making an examination of the roots themselves, and the first 2 ft. or 3 ft. of the stem. If it is root disease, such an examination quickly reveals a diseased and disorganized

condition of the outer tissues of the roots, while when the tree is cut into, it will be seen that a red discoloration, extending from the ground level for a distance of 2 ft. or 3 ft. upwards, is present in the stem. This may occur as a ring towards the outside, or as a general discoloration of the tissue near the centre of the stem. The death of the roots and the discoloration of the stem are the two absolutely distinguishing signs of the disease.[1]

From the personal observations of four of the best known authorities,[2] it seems probable that the disease in Ceylon is quite distinct from that which prevails in the West Indies. According to Petch, the following are the symptoms of the disease as it occurs in Ceylon:—

(1) The outer leaves wither and droop, usually remaining for a long time suspended vertically round the stem.

(2) The tree becomes barren, owing to the suppression of the flowering branches.

(3) The new leaves are successively smaller, so that the crown becomes a mere handful of yellowish leaves.

(4) Finally, these small leaves wither and decay.

In face of these descriptions Rorer believes that the two diseases are quite distinct and

[1] *Bulletin* No. 70 of the Imperial Department of Agriculture, Barbados, already referred to.

[2] Butler of Pusa; Petch of Ceylon; Stockdale of British Guiana; and Rorer of Trinidad.

due to different causes. Of the above symptoms, he argues, No. 1 is the only one which agrees with the Trinidad disease. Though trees have become barren when attacked by root disease, it is not from a suppression of the flowering branches, but rather from a falling of the miniature nuts and flowers. Moreover, there is here no such diminution in size of leaf as Petch describes. This feature of the Ceylon root disease seems to coincide with a disease found in Trinidad, to which Rorer has given the name of "little-leaf," from the very characteristic dwindling away of the leaves. Another point which tends to show that the two forms are distinct is the fact that in the Trinidad disease there is always the red ring in the tissues of the stem, which is not mentioned by Petch as a characteristic of the Ceylon disease. Finally, Petch has found the mycelium of a *basidiomycetous* fungus in the basal part of the stem tissues, which is not the case with the palms in the West Indies.

Stockdale, in his official description, as published in the *West Indian Bulletin*, stated that the outward appearance of the trees suffering from this so-called root disease is much the same as that of trees attacked by bud-rot, especially in cases where the outer leaves are the first attacked; in fact, it is impossible to distinguish the two in the field unless the palm is felled. The disease is first shown by the leaves, which have a somewhat wilted appear-

ance. They then turn yellow, beginning at the tips, and finally dry up, blacken, and hang down from the crown. At times the leaves break across, either near the tip or a foot or more from the stem. The broken part may fall to the ground or remain hanging to that part of the petiole still attached to the stem. If the attacked tree has reached the bearing age, the nuts do not mature but fall to the ground, and the flowers subsequently produced do not set fruit. After a number of the leaves have become yellowed and dried, it is only a question of time before the terminal bud becomes a putrid mass and falls over, and the palm eventually dies. When a coco-nut palm is affected by any disease or pest, the terminal bud, in the advanced stages of the disease, almost invariably becomes involved in a rot. This must not be confused with the bud-rot disease, which appears to be a specific disease, with the roots, stems, and leaves sound, while the bud only is in a diseased condition. It is only when the roots are examined that one can tell for certain whether the tree is suffering from root or bud disease. Stockdale on examining the root found the cortical cells were shrunken, and the large, dark-coloured, septate fungous hyphæ were seen between and within the cells. After carefully examining the red discoloration of the stem through the microscope it seemed most probable, by those making the investigations, that the discoloration of the stem was due principally to

the disorganization of the functions through the stoppage of supplies from the roots. It is this stoppage of the supplies which, as already stated, directly causes the tree to die from want of water. The fungus attacking the roots in the West Indies was identified by Stockdale, we believe, as belonging to the genus *Botryodiplodia*, and Stockdale concluded that the fungus which he found fruiting on the leaves was the same as that which he had observed in the roots, and was the cause of the disease. Rorer has also carried out extensive investigations, and the results of his work agrees fairly well with that of Stockdale and may be summarized as follows in comparison with Petch's description from Ceylon:—

(1) Hyphæ were seen in the old diseased roots, and in the soil about the roots.

(2) No fungous mycelium was seen in the discoloured tissues from any of the stems.

(3) The dark-coloured mycelium, characteristic of *diplodia*, and the *pycindia*, were found in the old leaf bases.

(4) No mycelium could be seen in root or leaf tissues showing, the first evidence of discoloration.[1] Frequently it is noticed from investigations in the West Indies that the leaves do not hang down around the trunk, but the petioles break across, leaving the sheathing

[1] Rorer goes very fully into the matter in his Report in Circular No. 4 of the Trinidad Board of Agriculture.

portion on the trunk, while the foliage portions of the leaves have fallen to the ground.

Both bud-rot and root disease seem to be aggravated by marshy, undrained lands, one reason given to prove this being that it was noticed in centres badly attacked, the trees never died on a hillside. Root disease seems likely to spread, owing to the mycelium apparently being capable of spreading through the soil from root to root. Its ability to do so depends a good deal upon the cultivation. Any condition of the soil that is unfavourable to the palm may favour root disease by hindering free root development. Excessive moisture and excessive drought, for instance, may favour the conditions of the disease.[1] The latter—drought—can be remedied by irrigation, the former—excess of moisture—by careful attention to drainage, and to the mechanical condition of the soil.

Unfortunately we cannot go into details, as to the remedies, but must refer our readers to Mr. Stockdale's, Mr. Rorer's, and other expert reports. For root disease, so far as we know at present, it seems probable that only the most drastic measures are likely to provide permanent relief; and even then it is feared that the disease, if a bad "break-out" occurs, can only be held in check rather than absolutely exterminated. But if held in check that will

[1] We are quoting Mr. Stockdale's excellent report again or basing our remarks on what he says.

be fairly satisfactory, for if this is done continuously, the trouble, like hydrophobia in large towns, will probably die out in time.

Examples show that there is sufficient food in the form of decaying vegetable matter in the old palms, &c., to continue the life of the fungus, and therefore all dead and diseased material in an infected area should be entirely destroyed and not left to accumulate. In theory, all dead and dying trees should be cut down and burnt. As already stated, this is easier said than done, especially when full of sap and bearing green leaves. In such cases they must be cut up and deeply buried with lime. Those used to charcoal burning might, however, collect and burn a quantity in a pit (see p. 235 *re* charcoal burner). No refuse, leaves, husks, or any rubbish whatever should be left about, as beetles, fungi, and other pests are spread by them. All should be buried or burnt, hence the desirability of having the fire constantly going. Besides, the ash is very valuable as a fertilizer, especially with water-logged land. It may even be necessary to extract the root if a radical cure in both senses of the word is looked for, in which case loosen the earth all you can, and get the stump out as nearly as possible complete. A fire can be lighted in the hole, as by doing so the roots left in, or at least fungus, &c., may be further destroyed or rendered harmless.

We are glad to see that Mr. Stockdale

urges, as was done in "Soil and Plant Sanitation,"[1] that all planters should combine to keep their estates clean, for one careless planter can become a permanent source of infection to his neighbours, and spread disease all round.[2]

When mycelium undoubtedly exists in the soil, such affected areas should be isolated by cutting trenches, 12 in. to 18 in. deep, round them, even including apparently healthy trees within the entrenched area. As with *fomes semitostus* on rubber estates, all the soil must be thrown within the diseased portion, and left to the destructive action of the sun, aided, as suggested, by a bonfire perhaps, made to burn low and smoulder, to avoid scorching the tree. Some lime scattered over the turned-up soil and in the trench would do no harm and might be an advantage.

In spite of all that is said, and, at times, with reason, about the disadvantages of catch-crops,

[1] Price 11s. post free. *Tropical Life* Publishing Department.

[2] The *Malay Mail* of January 31, 1912, discussed this question both for rubber and coco-nuts. Mr. Main, at the annual meeting of the Malacca Planters Association, on January 28, urged that the Government should be asked to appoint an inspector of rubber, in the same way as they had appointed one for coco-nuts, and that certain penalties should be inflicted on planters who failed to cut out and destroy diseased trees. The discussion that followed, and reports from elsewhere, show that plant-disease inspectors, the same as city sanitary inspectors, should be appointed at all large producing centres.

&c., on estates, remunerative rotation crops might be grown on badly infected areas for a year or two before replanting, if only to work out and eliminate the disease by reducing the richness of the land. Careful cultivation also helps, and possibly, urges Stockdale, green dressings of leguminous plants might be profitably grown and ploughed in.

The cultivation of land under coco-nuts is as a rule neglected, and instances have been noticed where the yields of nuts on old plantations gradually diminish in size, year by year. Better cultivation and drainage would both offer more favourable opportunities for the coco-nut palm, and be of considerable value in dealing with root disease, especially in wet areas with soil of a clayey nature, and would afford a better chance for the palm to make use of plant food, either from the soil or when applying manures. Above all feed up the trees. Stockdale (p. 370 of his report) quotes the case of a planter in Trinidad (W.I.) who obtained, through judicious applications of manures, 120,000 nuts per year from an area that gave only 40,000 nuts per year five years previously. This emphasizes the fact that the coco-nut readily responds, in some soils at least, to liberal applications of manure; and there is no denying the fact with all diseases, but especially with root disease, that by encouraging healthy growth and increasing the vigour of the trees, they will be able to better withstand fungous attacks.

Before leaving this question of coco-nut palm diseases, we would like to endorse what Mr. Stockdale said in his (1906) report regarding the possibilities of reducing or eliminating disease by the introduction of disease-resisting varieties. "Where fungus has completely devastated large areas," he tells us, "the trees should not be allowed to stand and rot, for that would only be a nursery for the development and spread of the disease. Whilst in badly infected districts it would appear as if all varieties are attacked, if every coco-nut planter would note the comparative resistance of the different varieties, considerable advance in the direction of introducing and propagating disease-resistant palms might soon be made. Several planters state that a variety known as the 'Green Spanish' is very hardy, and able to withstand attack much longer than other kinds."

OTHER PESTS.

"The West Indian Pamphlet" No. 70 reports the following:—

SUCKING INSECTS.

Bourbon aspidiotus—*Aspidiotus destructor.*
Coco-nut snow scale—*Diaspis boisduvalii.*
Coco-nut mealy-bug—*Pseudococcus nipæ.*
Glassy star scale—*Vinsonia stellifera.*
Black line scale—*Ischnaspis longirostris.*
White fly—*Aleyrodicus cocois.*

Biting Insects.

Caterpillars of a large butterfly—*Brassolis sophoræ.*

Palm weevil—*Rhynchophorus palmarum.*

Giant moth or sugar-cane borer—*Castnia licus,* also *C. dædalus.*

Scale insects and white fly, we are told, may attack young coco-nuts, either in the nursery or in the field. If plants in the nursery are attacked they should receive an application of some insecticide, in order that they may be rendered free from these pests before they are transplanted into the field. The Bourbon aspidiotus, the coco-nut snow scale, the coco-nut mealy-bug, and the white fly may all be satisfactorily controlled by means of an oily or soapy wash, such as kerosene emulsion or whale-oil soap; while the glassy star scale and the black line scale should receive an application of one of the rosin mixtures. If several different insects appear on the same plant, a wash such as rosin compound and whale-oil soap may suitably be employed for their control, or possibly one or other of the advertised insecticides and scalicides may be found to be even more effective.

Insecticides.

The washes just referred to may be prepared as follows:—

Whale-oil Soap.—Dissolve 1 lb. of whale-oil soap in 1 or 2 gallons of warm water.

Kerosene Emulsion.—Dissolve half-a-pound of hard soap in 1 gallon of boiling water. Add two gallons of kerosene to the hot liquid and immediately churn with a syringe or force pump till the mixture becomes creamy and all the oil is thoroughly combined with the soap solution. Properly made emulsion will not show any free oil on the surface, even after standing two or three days. This is the stock solution. Make up to 33 gallons. Use only rain-water, or soft water (*i.e.*, water without lime).

Rosin Wash.—Mix 20 lb. of rosin, 3½ lb. of 98 per cent. caustic soda, and 3 pints of fish oil. The rosin and caustic soda must be pounded before mixing. Cover this with about 2 inches of water, and boil. When the liquid is clear, *slowly* add water, still boiling the mixture, till the whole is made up to 15 gallons. This is the stock solution and can be made up to 100 gallons when cold, using only rain-water, or soft water.

Rosin Compound.—Mix 4 lb. of powdered rosin, 3 lb. of powdered washing soda, and 1 gallon of water. Boil, and when all is dissolved, *slowly* make up to 5 gallons. Boil the mixture till it becomes a clear brown colour. This is the stock solution. Make this up to 30 gallons.

Rosin and Whale-oil Soap Compound.—This is composed as follows: Rosin 4 lb.; washing soda 3 lb.; whale-oil soap 10 lb. With the

rosin and soda make 4 gallons of rosin compound stock solution as above. Stir the whale-oil soap in 5 gallons of hot water; mix the two whilst hot. This is the stock solution. To every gallon add 4 gallons of water. An alternative method is to make the rosin compound stock solution. For use, mix 1 gallon with 10 gallons of water and stir in $2\frac{1}{2}$ lb. of whale-oil soap. Every 45 gallons of wash should contain the above ingredients, however mixed.

Whale-oil Soap and Kerosene Emulsion.—The ingredients are: Whale-oil soap 10 lb.; kerosene oil 12 pints; water 20 pints. The whale-oil soap should be boiled in water until it is thoroughly dissolved, and the kerosene churned in to form an emulsion as described on p. 267. This is the stock solution with the kerosene emulsion, and is sufficient to make 25 gallons of spray mixture, using 1 pint of stock solution to 4 pints of water. It might be found, under certain circumstances, that a more dilute mixture would be useful, and trials might be made of different strengths down to 1 pint of stock solution to 8 pints of water.

Application of Insecticides.

These washes are usually applied by means of a spraying machine or of a garden syringe; but young plants in the nursery may be treated by dipping them into a tub or trough of suitable size, or by washing them with the insecticides,

care being taken not to damage them in the operation, by roughly handling the leaves. Whichever of these two methods is employed, the wash should be carefully rubbed over the entire surface of the leaf with a piece of sponge, or soft cloth. When the liquid is applied as a spray, the force with which it strikes the surface of the leaves enables it to penetrate the waxy secretion covering the insect, but when dipping or washing is resorted to, it becomes necessary to assist the penetration of the liquid in the manner indicated.

If the young trees in the field are attacked by these insects to such an extent as to render it desirable to apply an insecticide, it will probably be found advantageous to use a knapsack or a barrel spraying machine, while the latter would also be useful for spraying older trees.

Among commercially valuable trees in the Philippines, according to Charles S. Banks in the *Philippine Journal of Science*, vol. i, Nos. 2 and 3, 1906, few are attacked by so small a number of insect pests as the coco-nut; but, on the other hand, the destructive action of this limited number is very great. The trunk of the coco-nut does not have its important conducting tissues in or immediately under the bark, as is the case with cacao, coffee, or the mango. For this reason, even though the tree were completely girdled,

it would not be destroyed, as would be the case with the trees just mentioned. On the other hand, insects attacking the growing point would soon kill this part, after which the remainder would speedily die, and, in fact, this result is the one which almost always is encountered. Certain insects enter the crown and destroy it ; shortly afterwards the leaf turns yellow, the fruits, if any are present, drop off, and the tree eventually dies. It is therefore clear that any method which prevents attacks of this kind will preserve the life of the tree.

The following pests attack the trunk and undeveloped leaves and flowers of the coco-nut palm :—

The rhinoceros beetle (*Oryctes rhinoceros*, L).—Very common throughout the Philippines, Ceylon, Java, India, West Indies, &c. All the *Oryctes* genus have a predilection for the coco-nut and smaller palms. Its presence is indicated by the large, irregular holes in the trunk of the trees or at the base of the largest petioles of the leaves. The *Oryctes* does not gnaw the old, hard wood; at least no case was reported up to 1906. Mr. Banks gives full particulars of the beetle, its life history, habits, &c., extending to some thirteen pages (142 to 154) of closely printed matter in the *Philippine Journal*, accompanied by some excellent photographs. The remedies suggested are extraction by means of a long, hooked steel wire thrust into the hole, then given a half

turn to engage the insect and withdrawn, let us hope, with the pest on its end. The operation requires decision and practice, for the beetle has a well armoured, smooth coat, and but few projections on its body, so that unless you strike it between the body and the head, it is difficult to pierce. When the insect has been removed, the hole must be plugged to prevent further visitors; for this tar and sand, plaster and sand, or clay, plaster, or cement are recommended. The mixture, whichever is chosen, must be forced into the holes as far as possible, in order to enable it to act as a deterrent to the decay caused by the entrance of moisture subsequent to the attacks of the beetle. The work must be done well to avoid leaving any chance of ingress for others. Other remedies include spraying the crown of the tree with a mixture of Paris green and flour thinned out with 10 or 12 gallons of water for each tree. The natives in the Philippines are said to pour pure urine into the crown of the affected coco-nut trees with success.

Asiatic palm weevil or red beetle (*Rhynchophorus ferrugineus.* Fabr.).—According to Señor Vicente Reyes, of Santa Cruz, Laguna, P.I., it has been observed that coco-nut palms, the green leaves, blossoms, and fruits of which appear in perfect condition, fall to the ground without having any signs of decay, as though struck by a hurricane. In such instances it

has been noted that the palms from the roots to a metre high in the trunk are completely undermined, the interior pulverized like saw-dust, and filled with nests of these worms, which have gained entrance through the roots and gnawed their way upward, deriving maintenance from the trunk. This shows that the Asiatic palm weevil has been at work, and enables the planter to realize the gravity of its attacks; it enters the tree through the smallest wounds, leaving no external trace of its work, so that all its ravages are committed where not suspected; hence it is an extremely difficult enemy to combat.

To this pest Mr. Banks devotes six pages in the same publication (154 to 159) concluding, as usual, with preventives and remedies, by which we learn that the Asiatic weevil can only obtain access to the interior of the tree through wounds or holes caused by the toddy-gatherers, or the rhinoceros beetle or other pests.[1] For this reason mutilation of the trees should carefully be avoided, and if it is necessary to climb the trees, bamboo ladders must be used instead of allowing the men to cut notches in the trunk to mount up by. If, in spite of all precautions, the weevil gains entrance, the work of ousting them is extremely difficult. It is at times possible to dig them out with a wire hook, the

[1] Does this not tend to contradict Señor Reyes's statement just above that the worms, if not the adult beetle, gain an entrance through the roots?

same as with the rhinoceros beetle, but if this fails, as none of the authorities which we have consulted seem to have any remedy to suggest, the safest plan would be to carefully cut down and burn the tree, since it is apparently doomed, taking care in doing so that no pests are allowed to escape. Needless to say that every beetle or larva seen must be instantly killed, lest it makes its escape whilst the tree or portions of it are being carried through the estate.

Mr. Ridley considers that the red beetle is almost more destructive than the rhinoceros. He describes it as being nocturnal in its habits, flying at night to deposit its eggs in the coco-nut tree. Ferguson's Manual contains much useful information on this and other pests that we cannot include in this book.

The shot-hole coco-nut weevil[1] seems to puncture the palm from top to bottom with its exit holes; doubtless these insects would be susceptible to the same general treatment as that given to the Asiatic palm weevil. They are generally found in diseased trees, and Mr. Banks does not consider them a serious menace.

The four-spotted coco-nut weevil only attacks dead trees of very small size, and Mr. Banks reports that it is only met with in coco-nuts; it is not in any sense a menace to healthy trees.

Continuing his notes in the April (1906)

[1] Mr. Banks gives no scientific name to this pest.

issue of the same journal, Mr. Banks gives a bibliography dealing with all the insects known up to that date as attacking the coco-nut palm. In this section he tells us that two forms of Lepidoptera are found on the leaves of the coco-nut, say, the coco-nut skipper (*Padrona chrysozona*, Plötz) and the coco-nut slug-caterpillar (*Thosea cinereamarginata*, Banks). Neither is likely to prove a very serious menace to the trees; each attacks the leaves after they are practically full grown. They seem to attach themselves to a single leaf until the whole is devoured. Although not found in quantities sufficient to form a menace, these pests tend to debilitate the trees by eating the leaves, and their larvæ should be destroyed whenever met with. Two parasites, the *Chalcis obscurata* (Walk.) and an unidentified Braconid, attack the larvæ of the skipper, which they kill through pupating in the pupa of the skipper.

Coccidæ or scale insects, urges Banks, do very considerable injury to the coco-nut palms, for it is rare to find one which does not, by its yellow or brown leaves, indicate the ravages of these pests, which may easily escape attention. In the Philippines, so far as is known, seven species of Coccidæ are found upon the coco-nut. Of these, the *Aspidiotus destructor* (Sign), an extremely prolific scale, is by far the most important and destructive; next comes *Chrysomphalus propsimus* (Banks), a species

which has usually been found in great numbers on all trees examined in Manila and in the provinces. The scales crowd themselves upon both surfaces of the leaves of neglected or deformed trees, and frequently as many as four or five are found overlapping each other. Other scale insects include :—

Parlatoria Greeni (Banks), a delicate but prolific scale. It merits attention because of the possibility of its great increase if neglected. It is of a flat shape and grey colour, and difficult to detect.

Chionaspis candida (Banks), showing a small, pure white spot. This scale multiplies rapidly, usually in the protected parts.

Lepidosaphes Mcgregori (Banks) is comparatively rare. It occurs on both sides of the leaves, especially on old ones, but seems to prefer the upper surface near the midrib. It may at times, although rarely, propagate under favourable circumstances to the extent of being injurious. It is always encountered singly. The most noteworthy features which distinguish it are the pair of white, waxy, horn-like projections on the front of the first pellicle, the light colour of the female puparium, and the regularity of its transverse striæ.

Lepidosaphes unicolor (Banks) is met less frequently than *L. Mcgregori* and therefore less likely to prove a menace. It has a narrower, interior margin, and no waxy horns in old specimens.

Paralecanium cocophyllæ (Banks). — This always occurs upon the inferior surface of the leaf. The male puparia are much scarcer than those of the female.

The best remedy for such pests is to watch for and remove all malformed and defective leaves, and to destroy trees suffering from beetle attacks, as these tend to attract them. Those trees which are the healthiest and best cared for are the ones which will best withstand the pests. Spraying with lime-sulphur and emulsions do good ; the soap and oil in the latter form a skin over the insects, and so smother them.

The larvæ, pupæ, and adults of *Silvanis surinamensis* (Linn.) and *Necrobia rufipes* (De Geer) attack copra. Carbon bisulphide might be used successfully, but would probably prove detrimental to the copra owing to its power of dissolving oil. Mr. Banks includes excellent illustrations of all these pests, and of the trees, leaves, &c., attacked, as well as a bibliography of work and reports published up till then on the question of diseases, making these two issues (January and April, 1906) of the *Philippine Journal of Science* invaluable to anyone studying coco-nut pests.

According to Progress Report LVIII, dated March 7, 1912, of the Ceylon Agricultural Society, Mr. Madanayake, Agricultural Instructor, reported on the diseased condition of large patches of coco-nuts near Padukka

and forwarded specimens, which were submitted to the Government Mycologist, who reported as follows :—

"The leaves are attacked by *Pestalozzia palmarum*, a very common leaf disease of coconuts and other palms. It is rather more prevalent than usual just now, probably owing to the more ordinary infection during the prolonged rains. As a rule, it occurs only on the older leaves ; if it attacks the young leaves it is a sign that the tree is not in good health, and requires cultivation and manuring."

Mr. N. Wickremaratne, Agricultural Instructor, reported as follows in submitting specimens of diseased coco-nut fronds :—

"I inspected some coco-nut trees on an estate in Kalahe, in Galle, said to be attacked with some disease, and submit specimens of leaves, roots, &c. The estate in question is about 2½ miles (in a direct line) from the sea. The trees are about eight years old, some in bearing and some not. The land is hilly. The soil varies in character, and trees in several places on different soils are attacked. The disease was detected about two months ago. There are rubber trees, three to four years old, among the coco-nuts. Dark brown spots first appear on the leaflets, which ultimately become dry and break away, leaving only the 'ekels.' The lower branches are first attacked, and the disease travels inwards. In course of time the tree dies. I had one of the

trees uprooted and examined the root; the lowest roots were unnatural in colour, and when split open showed some dark spots. The disease appeared to be spreading. The trees attacked looked like those devastated by caterpillars."

On the above, Mr. Petch, Government Mycologist, has been good enough to make the subjoined report:—

"The leaves are attacked by the common coco-nut leaf disease caused by *Pestalozzia palmarum*. As a rule, this is confined to the older leaves, and does very little harm. If it attacks the young leaves, it is a sign that the tree is in poor health. Such trees should be manured with a potash manure. The death of a frond in the middle of the crown is the chief symptom of a disease which I am at present investigating. Up to the present its cause has not been ascertained. Apparently it has nothing to do with the root, and it is not bud-rot. Is Mr. Wickremaratne certain that the trees which exhibit this symptom die off? That is a point which we have not yet been able to ascertain in other instances. I hope to furnish further particulars of this disease shortly."

Towards the end of the book we discuss the comparative values of common salt and kainit as possible remedies of the above disease, especially when potash is needed.

MANURING.

We must apologize for the somewhat disjointed nature of this section, but believe that, however unsatisfactory this may be from a literary point of view, it is better to give our notes as collected, than to try and blend them into a single, even-running whole, and possibly make a mistake in doing so. Writing for all centres, we thus leave each to look for what they wish to know in the particular spot in which they are interested, only concluding the whole with four or five formulas or combinations recommended, according to the soil to receive them, and not according to any particular centre. Taking the Philippines first, we see clearly what the coco-nut as a whole takes away from the ground; having done this we include some general notes on manuring, and then go in for special mixtures which have been tried and given excellent results. We do not, however, pretend that what suits one centre, or even an estate in the centre, will suit the surrounding lands; we only give such information as we believe to be correct, and to show the planter along what lines to work. Having done this we must leave him to make his own experiments, but shall be very pleased to help where and when we can, and, above

all, to hear of the results obtained from the various formulas recommended.

First let us drive home again the need of regular, adequate supplies of water at all times. Water is necessary, and must be constantly at the disposal of the palms, to convey in solution the plants' mineral and nitrogenous raw food up to the crown. The quantity of mineral food which the tree takes up is roughly proportional to the amount of water which it absorbs. Increasing the plants' transpiration has, then, the same effect on them as applying a fertilizer to the ground; without the water the fertilizer will do little or no good.

Nuts from the San Ramon Experimental Farm (P.I.) were found to contain nitrogen, potash, and phosphoric acid in the proportions shown on p. 292. We have only to turn to the *Manila Journal of Science* to realize how important water is to the palms. There we are told (January, 1906, p. 18) that when nuts first appear on the palms, say, at an age of five to nine years, the tree is bearing at least 20 leaves, whilst in vigorous old trees the number increases to 25, 30, and even to 35 leaves. Each of these leaves is from 5 to 8 metres long, with about 80 pairs of pinnæ, large and small. Passing on to p. 33, in the same journal, we are told that, allowing 150 pinnæ to the leaf, and 25 leaves to the tree, this indicates a total daily transpiration for the tree of 38,551 grm. Estimates made in this

way of the total amount of water transpired have ranged between 28 and 45 litres per day. . . . The total transpiration for seven hours, from 9.20 a.m. to 4.20 p.m., on February 14 (of a single leaf), was :—

Mature leaf	2·70 grm.
Six months older	1·68 ,,
One year older	3·37 ,,

Some calculations (of the total water transpired by an entire tree) are as high as 75 litres per day, but at the rate of 28 litres per day (only) the annual transpiration would be equal to 10,220 litres (2,235½ gallons roughly) . . . . *trees judiciously irrigated have nothing to fear from a drought, however severe.* . . . There is no doubt that dryness is one of the causes of the fall of the leaves . . . a palm that has not the vitality to support its leaves will neither bear many nuts nor be able to ripen those produced.

Soil.

A few notes may now be made on the conditions of the soil most favourable to the growth of the palm. Without entering too far into the realms of botany, it is necessary to remember that the roots are large and fleshy instead of fibrous ; and this points at once to the necessity of having a fine permeable soil. That fact alone explains why coco-nut palms are naturally found along the seashore, where the soil is of a sandy nature. But the seashore

has other advantages. It is now generally recognized that the plant foods are taken up in dilute solution, and the water so absorbed is then transpired through the large leaf surface. As stated on p. 280, there is a distinct connection between the transpiration through the leaves and the amount of plant food taken up, and where the plants are situated in a good airy position the vigour of the trees is best assured. Fully exposed to the prevailing wind, with a more or less constant supply of water, the palms yield profitable harvests of nuts; and on these coastal tracts it is only necessary to avoid storm centres, where violent gales would tear the leaves and dislodge the young nuts, to ensure success and obtain regular profits.

Situation.

From what has been said, one can realize that soils of a clay formation, where drainage has received little attention, are unsuitable, for though the growth of the tree is practically governed by the water supply stagnant water is detrimental; also as the feeding area of the roots is limited to the surface, the palms are liable to be blown over by the wind. Sheltered valleys should also be avoided, though the poor yields from inland plantations can be largely attributed to the lack of water in the subsoil, to close planting, and also to the apparent indifference of the native planters towards any improvement either in the way of thinning out

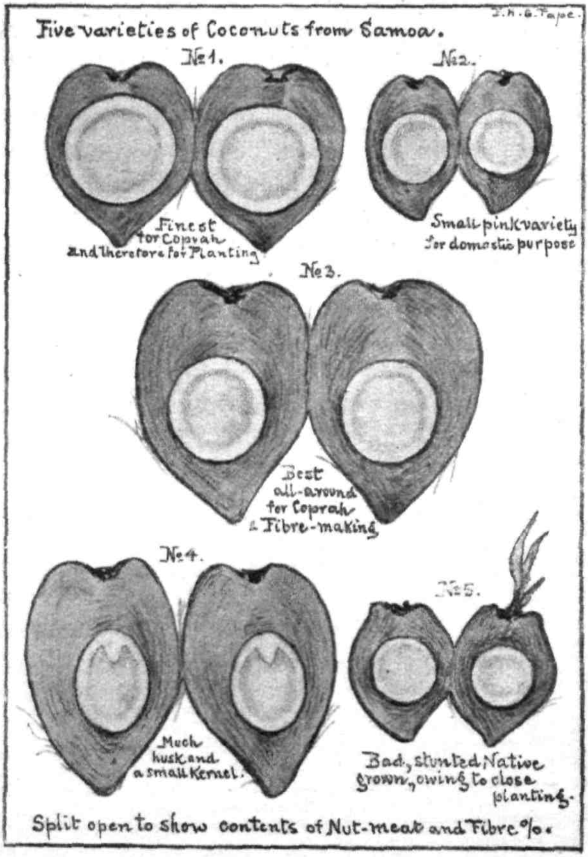
the trees or of undertaking some form of cultivation to produce a more friable condition of the soil. By adopting scientific methods of cultivation the area planted with economic plants has been greatly extended, and it is possible to create conditions under which these plants thrive just as well as in nature, and in many cases far better. So one hopes to extend the region of coco-nut culture from the coastal areas to the inland districts through due attention to seed selection, irrigation and drainage, planting in orchard form so as to have the maximum amount of light and air, and regular cultivation and manuring to restore the plant foods removed by each harvest of nuts. But there are two real objections to these inland areas. Firstly, in some cases they may be fever-stricken districts, and, secondly, it is often very difficult to get the nuts and by-products down to the local markets. But engineering and medical science are making rapid progress, and even the "White Man's Grave" is no longer the isolated death trap that it once was.

SELECTION OF NUTS.

As has been proved with other cultivated plants, such as wheat, due attention to seed selection is bound to give increased yields. The fruit as it is plucked from the tree is composed of two parts; the real kernel or flesh from which the copra is obtained, and the outside protective portion composed of thick

GENERAL VIEW ON ALEXANDRA ESTATE OF A. E. RAJEPAKSE, NEGOMBO, CEYLON.
Palms planted in 1908 as one-year-old seedlings, and manured every two years with

fibrous material. The proportion of fibre to the amount of flesh in the kernel is a very important point; and in Ceylon it has already been observed that according to the variety of the palm, 4,000 to 8,000 nuts are required to produce a ton of copra. Now copra is the thing that pays, and it is in the interest of the planter to consider where he is to obtain seed-nuts which are likely to give the best return. Where virgin areas are to be planted up, seed-nuts from some well-established district should be purchased. In the Federated Malay States seed-nuts imported from Penang, Perak, &c., have given good results, but where plantations have already been established, then seed-nuts should be selected from trees that are known to be good regular bearers under ordinary conditions of soil and climate. But the biggest nuts are not always to be recommended. It is surprising how in some of the medium-sized nuts is found a greater amount of flesh or meat, and this can easily be ascertained by cutting sections. The large nuts give a large amount of fibre, and consequently medium-sized nuts should always be chosen. The nuts, of course, should be fully matured, and from this point of view many argue that they should be allowed to fall naturally from the trees. This involves considerable damage to the young embryo, so careful handpicking—by reliable and experienced hands—is preferable. Now it requires considerable experience to tell when a nut is



COCO-NUTS IN SECTION, SHOWING PROPORTION OF MEAT TO FIBRE.

Possibly No. 3 has the most meat, the kernels being thicker than No. 1, and almost, if not quite, as large.

ripe. Inside the kernel is the milk, and when fully ripe, on shaking the nut a fine, clear, bell-like tone is emitted. But if germination has already started very little sound is produced, and if the nut be immature then a curious muffled tone is the result. A little practice is necessary to discriminate between these nuts, and the preference given to the San Blas nuts can to a certain extent be explained by the fact that there the natives are expert in the gathering of seed-nuts.

In San Blas, on trees selected for seed-nuts, a rough make of canvas or netting is suspended half-way up the trees to form a sort of sail into which the nuts drop when fully matured. By this way the young embryo is preserved from any possible damage. It is, however, quite different if the planter has to select his seed-nuts from a huge pile collected perhaps from different plantations. Those nuts which on shaking give no evidence of containing milk can be neglected at once, but as to the others he must just put them to the test of germination, and select from the most vigorous. This brings us to the question of a nursery.

Manuring in Nursery Work.

Now there are differences of opinion as to the value of a nursery. Many planters scout the idea of this as an unnecessary outlay, but the arguments in favour of a nursery are so strong that in most cases it is advisable to adopt this

preliminary method. And it is a method which will be found to pay. Suppose the nuts are taken direct to the plantation and placed out in the holes dug about 30 ft. apart, then if the area is extensive it is impossible to give the young seedlings the same attention as in a nursery. Our teachers in forestry recommend the formation of local nurseries for the supply of seedlings to plant up cleared areas, and here the conditions are practically the same. For every 200 acres a small nursery of about 3 acres should be selected on good deep soil where the drainage is satisfactory. During the early stages of germination, artificial watering is advisable: consequently a good supply of water near at hand is an advantage, and the nursery should be shaded as much as possible. The question of shade is an important one. If fully exposed to the sun's rays or to a continued period of drought, the young sensitive seedlings are liable to wilt and fade away, and even though they do eventually recover they have not the same vigour as those grown under shade. In open exposed areas where natural shelter cannot be obtained, part of the nursery should be roofed over with light bamboo work on which coco-nut leaves can be spread. At first a fairly close canopy can be maintained, but as the seedlings appear the shade may be gradually removed to admit more and more light and sunshine. The young seedlings are heavy feeders on phosphate and potash, and

some provision must be made to meet the continual drain on the soil of these constituents. The best method is to have a compost heap near at hand where all forms of refuse and rubbish are collected, but care is necessary to build up a good one. The refuse is best interlarded between layers of earth, and the addition of small quantities of lime helps towards the decay of the vegetable matter and counteracts any acidity set up. The compost, if made in spring, should be ready for application in the autumn after having been turned over and thoroughly mixed; basic slag and kainit can then be safely added; indeed, a handful of kainit applied to each nut is an advantage, since this tends to prevent the ravages of such pests as white ants.

Having selected the seed-nuts, it is advisable to store them in a dry place for about six weeks, since if this is not done the food store in the nuts is liable to decay through excess of moisture. Those nuts which may not have been quite ripe at the time of picking are thus given a chance to mature. The nuts are then laid lengthwise or in a slightly oblique position 6 in. apart in shallow trenches and buried to half their depth in the soil. Germination should take place in three to four months. If careful attention has been paid to the beds in the way of providing shade and artificial watering in times of drought, then those nuts should be thrown out as unsuitable which show no signs of germination at the end of that time.

Once the young shoots make their appearance above the ground their progress is rapid, and as the nuts in the first bed are very close together it is advisable to remove them to a second bed whenever the shoots attain a height of about 3 in. This second bed should be prepared carefully. The compost can be conveniently applied here along with basic slag and kainit to ensure that sufficient plant food is available in the soil, and the soil should be deep and well worked in order to allow of the proper development of the roots. Three to four feet each way is a convenient distance in the second bed, so that cultivation can be carried on between the rows to keep down weeds. This nursery method just outlined, extending to about two years, *i.e.*, six months in the first seed-bed and over one year in the second, can be strongly recommended, for though it entails much labour initially, the advantage in obtaining strong healthy seedlings for planting out certainly pays in the long run.

Transplanting.

From the nursery the young seedlings are removed to the plantation, and this is best done just before the commencement of the rainy season. In removing the seedlings care should be taken to leave the roots as entire as possible, and to see that no injury be done to the young shoots, especially at their junction with the nut. This transplanting stage is open to many grave

dangers. For instance, the young roots may be damaged, and, since the function of transmitting water upwards to the leaves is thus impaired, it is advisable, should a plant become damaged, to cut off about a third of the leaves, so as to regulate the evaporation from the leaf surface. But another danger is presented in that the period of transplanting may just coincide with the exhaustion of the natural food store in the nut and before the seedling has developed sufficient power to extract the necessary food material from the soil by the fine root-hairs. This stage occurs about six months after the appearance of the cotyledon or seed leaf, and a period of about three weeks elapses before the seedling can possibly accommodate itself to any new situation. Recognizing this danger there are many who maintain that the nursery stage is unnecessary, and that the better method is to leave the nuts in piles of ten or twelve, and transport those which have sufficiently sprouted direct to the plantation. Those who advocate this method claim that not only is the expense of the nursery avoided, but weakly plants can be readily seen and rejected. This method has been tested in Ceylon alongside the nursery system with two seed-beds, and in every case the latter has given better results, the palms coming quicker into bearing, their yields have more than compensated the planter for his initial outlay. In the plantation the palms should never be

less than 25 ft. apart each way, and planted in ordinary orchard form, but 30 ft. by 30 ft., or forty-eight palms to the acre, is generally found to be best, and some even advocate 40 ft. apart.

Mr. Herbert S. Walker, of the Chemical Laboratory, Manila, also writing in the *Philippine Journal of Science*[1] on the nuts from San Ramon,[2] showed that on analysis they contained nitrogen, potash, and phosphoric acid in approximately the following amounts in grammes :—

	Nitrogen	Potash	Phosphoric acid
Husk ...	1·609	3·915	0·017
Shell ...	0·660	0·947	0·459
Meat ...	4·683	2·475	1·740
Milk ...	1·542	1·313	0·171
Total	8·494	8·650	2·387

(1 lb. = 454 grammes.)

On a hectare (nearly 2½ acres) at seventy trees to the acre, 175 trees should be growing from which, at forty nuts per tree, a total of about 7,000 nuts may be expected. For San Ramon this is considered a high average, but for the sake of comparison it will serve the purpose. On the basis, therefore, of the analyses given above, the nuts would annually exhaust the following weight of plant-food, per hectare, from the soil; and to this must

[1] January, 1906.

[2] San Ramon Government Farm, on the West Coast of Mindanao, Philippine Isles.

be added the average loss withdrawn by the leaves, say, sixteen leaves per tree at 3 kilos each—8,400 kilos total weight. The total loss, therefore, would, after making allowances, probably work out as follows:—

Annual Loss	Nitrogen	Potash	Phosphoric acid
Nuts, per hectare ...	59·43	60·55	16·73 kilos.
Leaves, ,, ...	31·69	74·82	24·65 ,,
Combined loss ...	91·12	135·37	41·38 ,,

Were it not, therefore, that the root mass of a coco-nut draws nutriment from a depth of at least 2 metres below the surface of the ground, and outwards on all sides for from $3\frac{1}{2}$ to $6\frac{1}{2}$ metres distance, and even more from its base, the trees would be unable to find sufficient nourishment on the poor soils which are found, as a rule, on the sea-beach at San Ramon, or in Trinidad, W.I., &c., where the tree flourishes.

"It seems," adds Mr. Walker, "very probable in San Ramon at least, if not in most plantations along the sea-coast, that the nutritive material comes, not from the soil in which the trees are actually growing, but from an inexhaustible supply of water, laden with plant food, which is constantly sweeping down from the higher ground toward the ocean. The underground water supply would account for the flourishing condition of trees in a sandy soil near the sea, even in times of drought, when individuals further inland in higher and

less permeable ground would be dying from want of water."

In the case of the loss owing to permeable soils, artificial irrigation during the dry season seems to be of the utmost importance, and any addition to the fertility of the land, either in the form of manure or of a chemical fertilizer, would probably be repaid by an increased yield of fruit.

Analytical research showed a gradual increase in the proportion of meat, copra, and oil, with a corresponding decrease in the percentage of milk, indicating that the meat becomes firmer, and loses water, but *gains in oil*, as the nut increases in age. With some nuts which had been kept for six months the meat remained the same as regards total weight, but there was a marked drop in the proportion of copra and oil, probably due to decomposition or other changes in the meat. Both in very fresh and in over-ripe nuts there is a considerable deficiency in oil, but the principal loss is in the amount of copra to be obtained, due to the higher percentage of water as compared with the solid matter in the meat. In all the nuts the proportion of shell to the whole nut varied but little.

Whilst there are individual variations among nuts from the same tree, analyses made showed very conclusively the increase in the percentage of copra and oil as the fruit becomes riper. The average percentages of copra and oil, for

example, in the nut free from husk in the green fruit, are only 11·5 and 7·5 respectively, but they rise to 21 and 13·6 in the "fairly ripe," and assume a maximum of 23·4 and 15·5 in those which had been allowed to completely ripen whilst on the tree.[1] The proportion of husk taken from the seashore nuts (41·8 per cent.) is much larger than it is from those gathered in the interior (32 per cent.), but this is compensated for by the fact that the percentage of milk in the nut, free from husk, and of water in the fresh meat is considerably lower in the former than in the latter. Therefore, it appears to be very evident that the superiority of trees growing near the sea is solely due to the quantity, and not the quality, of nuts they produce. This is shown by the following particulars of 1,000 nuts procured from trees growing near the seashore, and the same number from those standing in the interior. The nuts were kept for a month before being touched.

	Seashore Nuts		Inland Nuts	
	Kilos.	Per cent.	Kilos.	Per cent.
Weight of 1,000 nuts ...	2,363	100·0	2,286	100·0
,, husks	897	38·0	703	30·8
Nuts, minus husks ...	1,466	62·0	1,582	69·2
Meat and shell	929	—	979	—
Milk	537	22·7	603	26·4
Shell (dry)	282	11·9	291	12·7
Meat	647	27·4	688	30·1

[1] Full explanations of the reasons for this, with carefully prepared tables of the analyses made (fourteen tables in all) are given; see *Philippine Journal of Science*, January, 1906, pp. 58-82, also in this book on pp. 406, 407, in the Section on Oil.

the natural requirements of the palm itself, but also the capacity of the palm for assimilating the various fertilizing ingredients must be borne in mind. In consideration of the foregoing, the following may be taken as a fairly reliable formula per acre: Nitrogen, 30 lb.; phosphoric acid, 45 lb.; potash, 45 lb.; lime, 30 lb.

With regard to the use of salt, there are conflicting opinions. Some planters maintain that upon suitable coco-nut soils—*i.e.*, light and permeable—common salt is positively injurious. At the same time, it is admitted that the coco-nut is able to take up large quantities. It is argued, however, that the records show that the presence of salt in no way contributes to the health, vigour, or fruitfulness of the tree.

On the other hand, it is stated that the benefits derived from its use are universally recognized. Be that as it may, the application of such a manure as potash in the form of kainit, which contains 40 per cent. of salt, should be quite sufficient to supply the necessary amount of that ingredient, and therefore salt as a separate or special fertilizer may perhaps be omitted without harm, if kainit is used.

In order to supply the necessary humus, stable manure should be applied in addition where it is obtainable; if it is not obtainable, then some green manure must be grown and turned in.

	Seashore Nuts				Inland Nuts			
	Sun dried		Grill dried		Sun dried		Grill dried	
	Kilos.	Per cent.	Kilos.	Per cent.	Kilos.	Per cent.	Kilos.	Per cent.
Copra ...	302	12·8	330	14·0	322	14·1	333	14·6
Oil ...	182	27·7	198	8·4	191	8·4	189	8·3
Moisture in copra ...	—	9·2	—	8·6	—	9·8	—	10·1
Oil ...	—	60·3	—	60·2	—	59·2	—	57·0

In conclusion, it is claimed that "the great porosity of soils near the sea, coupled with the fact that they are, as a rule, practically saturated with water at a distance of only a few feet below the surface of the ground, is the principal reason why they are more suitable for trees like the coco-nut, which require an enormous quantity of water for their growth. Chemically, there is very little difference between soils near the seashore and those inland; if anything, the latter (in the Philippines) is a little more fertile. The salt water from the sea has no influence on trees in its vicinity, as only amounts of chlorine so small as to be negligible were found to be present even at the bases of the coco-nut trees which were actually growing on the beach."

MANURING.

As with every other crop grown, it is necessary with coco-nuts, if good results are to be obtained, to return a certain amount of plant food to the soil, to make good any deficiency due to the removal of food by the crop. In order to do this effectively, not only must allowance be made for wastage and for

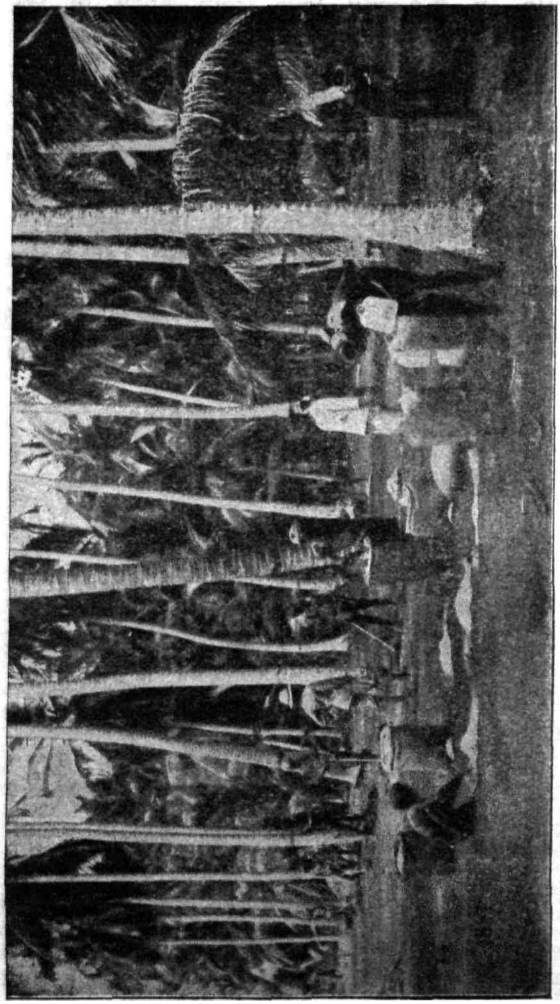
While it cannot be gainsaid that the judicious use of artificial manures is extremely beneficial, it need not, in our opinion, be made a *sine quâ non* and a fetish, as some very modern planters are inclined to make it, that every estate must be manured, as the practice, unless care is exercised, may be attended with a heavy and unnecessary outlay without corresponding returns. Wherever one has exercised sufficient care at the start, and has chosen the right location under the proper climatic conditions, it will be found that the materials locally obtainable for this process will, at the start, as a rule suffice, unless the soil shows a marked deficiency in one fertilizing ingredient. In the first place the coco-nut is not a delicate palm, but will respond gratefully and liberally to care and attention, and prove a quick, robust grower under favourable conditions even in only an average soil if the temperature and other conditions are right. The coco-nut tree thrives best where the soil is well provided with potash, nitrogen, phosphates, lime, and slightly saline substances. All these are, without exception, available on a plantation in ninety-nine cases out of a hundred, and it is the duty and foresight of the individual manager or owner to see that he always has them available in the right proportions. If he finds the trees are going back then he must look for the cause, and put back into the soil those constituents of plant-food which he finds are

View on Alexandra Estate of A. E. Rajepakse, Negombo, Ceylon.

These trees were fertilized every two years with a Complete Fertilizer.

running short. He possibly has either leaf-mould from the weeding and dead leaves, husks, shell, &c., &c., poonac[1] from oil-mills, stable and fish manure, the ashes from burnt timber and refuse heaps, lime from coral, shells or limestone formations and saline matter from the sea or in some cheap solid purchasable form. All these home-made manures not only provide the soil with fertilizing ingredients, but they also improve the physical condition, by increasing the proportion of humus in same. If the production of natural manures is insufficient to make good the lack of humus in the soil, then some green manure must be grown and turned in. For this purpose it is recommended to plant legumes under the coco-nuts, and, as already stated, it has been found that various other small close-growing plants, such as the mimosa, crotalaria and passiflora families, are much to be preferred to the bare soil or to a surface covering of grass. Contrary to general opinion grass always needs careful handling, as the roots are apt to form an almost impervious, felt-like mass which only the heavier rain-showers can penetrate, while the legumes have open crowns, and what is more important, enrich the soil with nitrogen owing to their capacity to fix the free nitrogen of the air, all of which goes to benefit the roots of the adjacent coco-nut trees. Where herds of cattle or pigs

[1] Poonac is the residue from the oil-presses.



[*By courtesy of the Potash Syndicate.*]

COCO-NUT CULTIVATION IN CEYLON.

Showing hoes in use for applying fertilizers to coco-nut palms.

COCO-NUT TREE BEARING FRUIT, FERTILIZED IN 1908 AND 1910 WITH A COMPLETE FERTILIZER.

Estate of A. E. Rajepakse, Negombo, Ceylon.

	Seashore Nuts				Inland Nuts			
	Sun dried		Grill dried		Sun dried		Grill dried	
	Kilos.	Per cent.	Kilos.	Per cent.	Kilos.	Per cent.	Kilos.	Per cent.
Copra ...	302	12·8	330	14·0	322	14·1	333	14·6
Oii ...	182	27·7	198	8·4	191	8·4	189	8·3
Moisture in copra ...	—	9·2	—	8·6	—	9·8	—	10·1
Oil ...	—	60·3	—	60·2	—	59·2	—	57·0

In conclusion, it is claimed that "the great porosity of soils near the sea, coupled with the fact that they are, as a rule, practically saturated with water at a distance of only a few feet below the surface of the ground, is the principal reason why they are more suitable for trees like the coco-nut, which require an enormous quantity of water for their growth. Chemically, there is very little difference between soils near the seashore and those inland; if anything, the latter (in the Philippines) is a little more fertile. The salt water from the sea has no influence on trees in its vicinity, as only amounts of chlorine so small as. to be negligible were found to be present even at the bases of the coco-nut trees which were actually growing on the beach."

Manuring.

As with every other crop grown, it is necessary with coco-nuts, if good results are to be obtained, to return a certain amount of plant food to the soil, to make good any deficiency due to the removal of food by the crop. In order to do this effectively, not only must allowance be made for wastage and for

are kept, their manure must be carefully stored in the compounds and made use of in the building up of the compost heaps already described, where all fertilizing constituents are mixed and worked up with earth, and left to decompose under cover until required, only needing water now and again when too dry.

Artificial manures have the most effect when applied to young palms, because at that stage the soil surrounding the roots is still unsettled and because the most rapid progress in the growing conditions takes place. Moreover, the application of cattle manures from grazing animals, even when available, cannot be resorted to because the leaves and tender fronds of the young trees are within the reach of domestic animals, and considerable damage would accrue to the plants from the eagerness of cattle to feed upon them, but when the leaves are up out of harm's way, cattle and pigs and even poultry can be allowed into the groves, and the more there are of them the better for all. The principal thing in all rational coco-nut cultivation should be to determine as nearly as possible, by analysis or otherwise, just how much of the aforementioned chief plant-food constituents there are in the soil and how much of these are available for the trees to use up in their growth, and in the formation of fruit, &c., for it must be remembered that analytical returns are not everything, it is not only necessary

to know what is in the soil, but also, and most of all, what it contains in a state to be assimilated by the palms. If the balance of results is favourable, and if on the whole the property looks flourishing generally, as shown in the appearance of the trees and the quality and quantity of the nuts, then it is not necessary to resort to the purchase of artificial manures at all. The plantation itself, with its refuse from the trees, and the weedings, droppings from the cattle and other domestic animals, &c., &c., can to a certain degree keep things going, but generally there is not nearly enough, and then something is palpably wrong. If adequate results are not obtained, and if the trees do not look up to the mark, then it is time to investigate and have recourse to artificial aids in addition to any local supplies. It will in most cases be a question of a lack of nitrogen and phosphates, but if potash is lacking it should also be supplied without delay.

In the early stages of its career the application of a generous supply of stimulating nitrogen is specially necessary to the coco-nut palm —occasional small applications of nitrate of soda would meet this demand—later on, when the fruiting stage is reached, heavier demands are made on the phosphates and potash, especially the latter, and these should thus be supplied every other year, together with lime and nitrate of soda, or other nitrogenous manure. It would perhaps be the better plan

to apply *half* the quantity given in the various formulas every year, instead of the larger dressing every other year.

The principal artificial substance on the market to replace nitrogen is the well-known Chili saltpetre or nitrate of soda, which contains nitrogenous constituents in a high degree (over ·15 per cent.). It must not, however, be applied in large doses at one time, but in small doses, so that it can be easily absorbed, as the soil does not retain it for any length of time. The great advantage of nitrate of soda lies in its being in a form of nitrogen which is immediately available to the plant, so that it becomes assimilated in a few days.

Some planters, whilst acknowledging their preference for nitrate of soda, complain of its tendency to attract moisture, which not only tends to deteriorate the nitrate itself, but any other fertilizer mixed with it as well. This should not be, and the fault lies with the user. Materials like cement, manures, &c., and especially nitrate of soda, should always be carefully stored away in a thoroughly dry place; if this be done, no trouble will be experienced. Out in the open, especially in times of drought, this very quality of nitrate of soda is one of its great advantages, for when mixed with a mulch it helps to increase the moisture available for the soil. In semi-arid regions the addition of sodium nitrate is stated to have actually shown a reduction in the need for water of some 30 per cent.

Then we have the guanos and complete organic manures, of which the Peruvian variety is to be chosen for preference, because it is more easily soluble and disintegrates more readily. Its percentages of nitrogen are about 6 to 9 per cent.; it also contains of soluble phosphoric acid 8 to 9 per cent., and potash 1 to 2 per cent. Fish guano contains rather more nitrogen than the above, besides some 4 to 5 per cent. of phosphoric acid, and about 2 per cent. of potash. Bone meal is used in several forms, but unless they are primarily treated and disintegrated, if not ground to powder, their constituents are difficult of solution. This form of manure is specially useful when reserve supplies are wanted; but like all home-made or local manures, large estates find the supplies available fall far short of actual requirements.

The manures best known for meeting the phosphatic requirements of the coco-nut palm are superphosphates and Thomas's phosphate powder or basic slag.

The manurial value of the superphosphates (ordinary and concentrated) depends upon their content of phosphoric acid soluble in water and in citrate of ammonia solution. Whereas the percentage of water-soluble phosphoric acid ranges from 12 to 20 per cent. in ordinary superphosphates, the concentrated superphosphates contain 40 to 43 per cent. water-soluble phosphoric acid, and 2 to 3 per

cent. phosphoric acid soluble in citrate of ammonia solution.

If superphosphate be applied to the soil, its phosphoric acid, being soluble in water, becomes disseminated throughout the soil, and is there absorbed by other constituents, as lime, magnesia, iron, and alumina, forming phosphates which are insoluble in water. In soils containing a fair amount of lime the water-soluble phosphoric acid is precipitated into phosphate of lime, which supplies the plants with available phosphoric acid; but on soils poor in lime the water-soluble phosphoric acid is either subject to being washed out of the surface soil, or is absorbed by the oxides of iron and alumina, forming compounds the phosphoric acid of which the plants can only assimilate with the greatest difficulty. The use of superphosphates should, therefore, be limited to soils which are not deficient in lime; on these 1 lb. of phosphoric acid in ordinary superphosphates has the same effect as 1 lb. of phosphoric acid in concentrated superphosphate.

Thomas's phosphate powder, a by-product in the manufacture of steel free from phosphorus, contains 15 to 20 per cent. phosphoric acid, 40 to 50 per cent. lime, and 4 to 5 per cent. magnesia. The phosphoric acid in Thomas's phosphate powder, although insoluble in water, is easily soluble in weak acids, and therefore readily assimilated by plants. In genuine Thomas's phosphate powder 80 per cent. and

more of its phosphoric acid is soluble in a 2 per cent. citric acid solution, which portion is considered quite as available as the water-soluble phosphoric acid in superphosphate. As the phosphoric acid in Thomas's phosphate powder does not undergo any changes in the soil which might reduce its availability, the use of this phosphatic fertilizer is not restricted to any particular class of soil, but can be applied with advantage to all soils. Its effects are most marked on soils deficient in lime, and on soils containing an excessive quantity of organic matter, in which cases the effects of the Thomas's phosphate powder are due not only to the phosphoric acid, but also to the lime it contains. The latter can be easily assimilated by plants, and, like every other form of alkaline lime, improves the mechanical condition of the soil, promotes the oxidation of the nitrogenous reserves, brings the soil potash in solution, and helps to neutralize and render harmless the organic acids of soils rich in humus.

Compounds of nitrogenous ingredients and superphosphates are highly useful in soils destitute of nitrogen ; it is, however, injudicious to apply them in conjunction with limes, slags or ashes, on account of the alkalis in them. The fertilizer trade has been at considerable pains and efforts to put on the market a series of patent fertilizers, already mixed for use with the various crops, and the leading makers and vendors supply clear-worded formulæ showing

their constituent parts, so that it is not difficult for the consumer to select the most suitable ones for his especial purposes or to arrange for special formulæ to be made up. All the best makers issue handbooks, pamphlets, &c., on the subject, free of cost. These are thoroughly reliable, and of great value at times. In the compounds, however, recommended in these, the percentage of nitrogen is nearly always too low, and it will often be well to supplement them by the application of a top-dressing of nitrate of soda.

In Ceylon a great deal of dependence is placed on systematic manuring by means of herds of cattle and other domestic animals. One head of cattle is kept for 2 to 3 acres of plantation. Their principal food consists of the oilcakes (poonac) from the mills and the herbage under the trees. At night the cattle are placed in kraals, and are bedded down upon thick layers of straw, which is frequently added to. After six months or so the kraal is shifted, and the manure in the old one is taken out and worked up with soil and the addition of bone meal and other compounds into a fertilizer. The dung from 100 cattle is about sufficient to spread over 10 acres. It would, under such circumstances, be quite feasible to keep up to 1,000 head of cattle on a good-sized plantation, and the time occupied in going round the whole area with the manuring process would not be long enough

for the effect of the manures to have been altogether lost before a second supply was available.

Piggeries are not of universal feasibility, except in places where the Chinese element predominates, or when their carcases can be exported, as Mahommedans and Buddhists will not eat pork. The breeding of ducks, turkeys, geese, and poultry might prove successful and feasible in some places, but, of course, such could even under the most auspicious conditions only be considered as a side-line to supplement the cattle-breeding proposition. It is wonderful how in the aggregate poultry manures tell on the compost heap, whilst for human consumption we have never yet been to any place where the supply of poultry was equal to the demand, especially if a town or port was within 10 miles of an important shipping centre.

The manuring of full-grown palms is carried out in a circle at some distance from the trunk (see p. 296). The roots near the base of the tree are callous, woody, and impervious, so their absorption-cells work best the nearer they are towards the tips. It is therefore necessary to exercise a lot of careful supervision over the labourers to get them to devote their best attention to this part, viz., the outer ring only. Two rough circles may be drawn for the purpose with the trunk as a centre ; one just about 6 ft. away from the

bole and another at a distance of 12 ft., according to the age of the trees, and the manure applied nearer to the outer ring than the inner one. In all cases care should be taken that the manure is supplied evenly and according to orders. Take note that large doses are not given to some, whilst others go short, so as to ease the work, which after a time becomes very monotonous and downright tedious.

It has already been said that the younger the palm, the more susceptible and capable it is of aiding the assimilation of nutritious constituents. This does not mean, however, that one need start manuring right away after planting, but it may be done for the best part of a year after the young plant has had time to get a firm system of roots in the new soil through which to take up its food.

Rain and other water supplies will have sufficed to nourish and develop the plant up to that date, after which, perhaps, judicious and oft-repeated manuring in small quantities can be applied. Frequent applications are in all cases better than large doses at one time, and at longer intervals. Near Negombo, in the Western Province of Ceylon, experiments carried on over eight years with regular and systematic manuring increased the yield of the trees so treated by 50 per cent. Mr. W. Freudenberg, an old and prominent resident whom we had the pleasure of meeting some years ago, has devoted a good deal of time

and money to the subject, and we quote some of his figures here. After a series of regular yearly manurings, a lot of ten-year-old coco-nut trees gave an annual yield per tree of eighty nuts, while the same trees previously when unmanured had only yielded fifty nuts. Another plantation of 63 acres on hilly land, with alluvial, pebbly soil, and not much humus over that, was subjected to regular manuring for six years. In the first two years the increase in yield was inappreciable, because the attenuated trees had to fill out, but for the subsequent years the yield rose rapidly, and showed in the end an increase of well over even 50 per cent.

Those acquainted with coco-nut plantations are quite aware that the trees in the neighbourhood of the stations are frequently more vigorous and produce larger crops than those even a few hundred yards distant. The natives attribute the larger return of nuts to a form of gratitude on the part of the trees for their inclusion in the family circle, but the real reason lies in the way of manure from the cattle sheds and other refuse of a fertilizing character. Not only is a higher yield noticeable, but the nuts are larger, and young trees on the plantations near the stations come earlier into bearing and yield even at their fifth or sixth year, whereas, in ordinary cases, a period of from eight to ten years usually elapses before the trees produce nuts. This

is by no means a small consideration, for a quicker return on the outlay is thus assured. Experiments on the manuring of coco-nut palms are still in progress, and up to the present we have only the guidance of the analyses of the various products removed by a year's harvest. Dr. Bachofen has shown by analyses that a crop of 1,000 nuts, *i.e.*, the produce of half an acre, removes the following quantities of plant food from the soil :—

Nitrogen	8·6 lb.
Phosphoric acid	2·4 ,,
Potash	18·7 ,,
Lime	2·3 ,,
Salt	21·4 ,,

making a total of 53·4 lb. of plant foods removed from the soil of half an acre by the crop alone, and besides this the trees have also to be considered and provided for.

These figures give us a working basis on which we can build up a manure mixture to replenish the soil with the more important plant foods. Assuming that fifty trees go to the acre, and the average harvest is fifty nuts per tree, then this means that 21½ lb. nitrogen, 6 lb. phosphoric acid, and 47 lb. potash are removed. These figures are taken from analyses of the nuts, so that allowing for the growth of, and nourishment for, the trees, we arrive at the following figures as being necessary for each acre after the removal of the crop :—

Nitrogen	29	lb.
Phosphoric acid...	14	,,
Potash	47	,,

Before deducing a suitable mixed-manure from these figures we must take certain considerations into account. The palms are known to be heavy feeders, but if found under suitable soil conditions, then the roots have a wider ranging power, and can draw to a greater extent on the original or latent supply of plant food in the soil. Then, on a young plantation, it is assumed that suitable methods of cultivation will be adopted, and for the first two or three years catch-crops of marketable value, such as corn and mountain rice, may be grown between the lines. The yields from these catch-crops will usually balance the cost of cultivation, but after the fourth year the leaves of the palms will have spread over the rows sufficiently to create too dense a shade for catch-crops. Cattle manure is rarely found in sufficient quantities for large plantations, and to supply humus, which is useful to conserve the moisture in the soil, a legume crop, such as soya-beans, velvet-beans or cow-peas, can be grown, and this, when lightly ploughed under, supplies the soil with nitrogen, which the bacteria on the roots have the power of building up from the free nitrogen in the atmosphere. On a fairly heavy soil a legume crop is of considerable value, since the roots open up and aerate the soil.

Bearing these facts in mind, we can recommend the following mixtures:—

No. 1			No. 2
100 lb.	...	Sulphate of ammonia	120 lb.
150 ,,	...	Bone meal	200 ,,
50 ,,	...	Superphosphate ...	60 ,,
100 ,,	...	Kainit	100 ,,
50 ,,	...	Muriate of potash ...	70 ,,
450 lb. per acre.			550 lb. per acre.

In many cases it may be found advantageous to substitute 130 lb. nitrate of soda for the sulphate of ammonia in mixture No. 1, and 160 lb. in mixture No. 2.

The first mixture is suitable for application during the first three or four years, but as soon as signs of the formation of nuts are observed, then the second mixture should be applied, in order to stimulate the trees as much as possible. Where green manures have been ploughed into the soil, then the quantity of nitrogenous manure, especially if nitrate of soda is used, can be considerably reduced. These mixtures have been based on the information gained from experiments on orchards where the effects of the various plant foods have been more or less established. For instance, it has been found that the effect of nitrogen is to increase the size of the fruit, but in order to obtain quality as well as quantity phosphate and potash must be added. These play a prominent part in the formation

of carbohydrates and albuminoids, and those who visited the stand of the Potash Syndicate at the recent International Rubber Exhibition, London, will remember the cross-sections of the coco-nuts, where a striking difference in the amount of meat was shown between those nuts from the manured and unmanured plots. The results from these experiments are just to hand. They were carried out in Ceylon by Mudaliyar A. E. Rajepakse, Alexandra Coco-nut Estate, Jaela. Both plots received four baskets of cattle manure of inferior quality, and one received in addition per tree :—

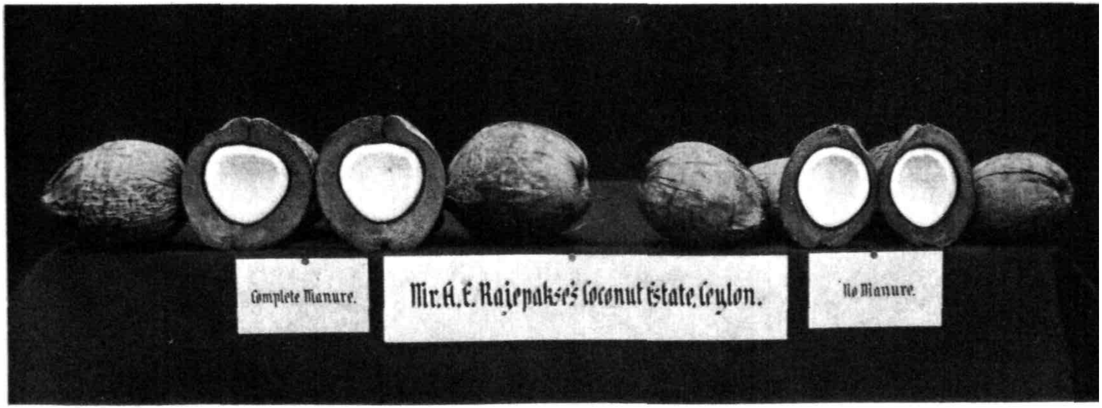
6 lb.	Bone meal.
3 "	Castor cake.
2 "	Fish manure.
3 "	Kainit.
1 "	Sulphate of potash.
15 lb. per tree.	

The "No manure" plot gave on an average twenty-two nuts per tree, whereas on the "fully manured" plot the average was fifty-one nuts per tree. Not only was the yield per tree more than doubled, but the quantity of meat or flesh in the kernels was also considerably increased.

We have been assuming that we are dealing with newly formed plantations, but the case is quite different when we come to deal with old plantations which may have been neglected for a considerable number of years. The vitality

COCONUTS IN SECTION

showing the effects of Manuring in increasing the size of the kernels:



The following complete manure was applied in addition to 4 baskets Cattle Manure:

15 lbs. per Tree { 6 lbs. Bone Meal, 3 lbs. Castor Cake, 2 lbs. Fish Manure, 3 lbs. Kainit, 1 lb. Sulphate of Potash.

of such trees is naturally low, and we must make up this by the application of plant foods before any appreciable difference can be noted in the yields. We often find in these neglected plantations, however, that the trees are too close together, and not only are the yields unprofitable, but these trees are often in a very unhealthy condition with bud-rot, and are thus a source of infection to healthier palms in the neighbourhood. The first step should be to thin out the plantation till the distance apart each way is not less than 25 ft. It is hard to convince a native as to the wisdom of this, but it will be work that pays. After this thinning, cultivation and manuring can be more uniformly practised. A heavy manuring should be given the first year or so in order to restore the vigour of the trees and to promote the formation of nuts. In such cases the first year's manuring may do very little beyond improving the appearance of the trees, but after the second year an increase in the crop is bound to take place. A manure composed largely of organic material is preferable, and the following mixture should give good results :—

Castor cake	250 lb.
Tankage	200 ,,
Sulphate of ammonia	50 ,,
Kainit	120 ,,
Muriate of potash	80 ,,
Sufficient for 1 acre	700 lb.

As soon as the trees show a healthy appearance, then Mixture No. 1 in the first table (p. 315) can be applied with advantage.

"Seeing is believing" is an old adage, and most of us are sceptical in that we require to be shown actual proof of a thing before we will believe it. It is only by actual experimental work that we can hope to convince the planters that the adoption of more up-to-date methods will give increased and profitable yields, and in view of the growing demand for copra and vegetable oils, which is creating something of a boom in coco-nut culture, owners and managers of plantations should test for themselves the value of adopting the more modern methods of cultivation and manuring suggested here.

Besides the mixtures already mentioned the following should prove very suitable for coco-nut trees planted in the undermentioned soils :—

MANURE COMBINATIONS SUITABLE FOR COCO-NUT TREES.

Nature of soil	Quantities to be applied per tree: 1-6 years old	7-15 years old	Older than 15 years
(1) Sand or sandy loams.			
(*a*) Deficient in humus—			
Basic slag	1-3 lb.	4 lb.	5 lb.
Muriate of potash ...	½-1 ,,	1¼ ,,	1½ ,,
Nitrate of soda ...	¾-1¾ ,,	2 ,,	2½ ,,
(*b*) Well provided with humus—			
Basic slag	¾-2 lb.	3 lb.	4 lb.
Muriate of potash ...	½-1 ,,	1¼ ,,	1½ ,,
Nitrate of soda ...	½-1 ,,	1¼ ,,	2 ,,

Nature of soil	Quantities to be applied per tree: 1-6 years old	7-15 years old	Older than 15 years
(2) Loamy soils.			
(*a*) Deficient in humus—			
Basic slag	1-3½ lb.	4 lb.	5 lb.
Muriate of potash ...	¼-½ ,,	¾ ,,	1 ,,
Nitrate of soda ...	¾-1¾ ,,	2 ,,	2½ ,,
(*b*) Well provided with humus—			
Basic slag	1-3 lb.	4 lb.	5 lb.
Muriate of potash ...	¼-½ ,,	¾ ,,	1 ,,
Nitrate of soda ...	½-1 ,,	1¼ ,,	2 ,,
(3) Clay soils.			
(*a*) Deficient in humus—			
Basic slag	1½-4 lb.	5 lb.	7 lb.
Muriate of potash ...	¼-½ ,,	¾ ,,	1 ,,
Nitrate of soda ...	¾-1¾ ,,	2 ,,	2½ ,,
(*b*) Well provided with humus—			
Basic slag	1-3½ lb.	4 lb.	6 lb.
Muriate of potash ...	¼-½ ,,	¾ ,,	1 ,,
Nitrate of soda ...	½-1 ,,	1¼ ,,	2 ,,

The following was recently sent out to Jamaica for use as a coco-nut manure on an estate planted forty-two to the acre (not forty-eight). As 4 cwt. (448 lb.) was to be used per acre, each tree received nearly 11 lb. of manure. The mixture, which cost £8 a ton, was guaranteed to contain :—

6 per cent. ammonia organic base.
18 ,, soluble phosphates.
2 ,, pure potash.

Without pretending to associate the following analyses of fertilizing materials with any of the foregoing remarks, we feel that they are of sufficient use and interest to take a note of :—

	Nitrogen Per cent.	Phos. acid Per cent.	Potash Per cent.	Moisture Per cent.
Goat manure No. 1	2·32	·47	3·72	37·48
" " No. 2	1·92	·76	3·01	20·77
Sheep manure	1·26	·59	2·54	39·66
Seaweed	1·18	·16	·93	19·22
Sugar. Filter press residue	·75	2·02	—	63·49

According to the Annual Report of the Porto Rico Agricultural Experiment Station for 1910, from which we take the above figures, the filter press residue, known locally as *Cachasa*, as thrown out from the sugar mills, with its two-thirds contents of water, is worth locally $4 a ton as manure. In the dry state, therefore, it should be worth, roughly, some $12 a ton.

It must not be forgotten that a great deal of the preliminary application of fertilizers will go to make the tree itself vigorous, giving it free and healthy growth and ample leaf development. Once it has reached that stage the fertilizers will go to increase the fruiting capacity. It is natural that a weakly or badly developed tree cannot produce large crops, so that the first object must be the development of the palm itself, to enable it to become and to remain in a condition to produce and support a maximum crop. The planter, then, must not be disappointed if the results of the first application of fertilizers are more marked on the tree itself than on the crop.

THE MULCH.

By O. W. Barrett.[1]

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The motto of modern agronomists should be, "Tilth, mulch, and microbes." The most important of these may be microbes, but mulch is a very big word, and one of the greatest factors in plant economy.

If there is one fundamental principle of plant cultivation that is neglected more than any other, it is unquestionably the artificial protection of roots from heat and dryness dangers.

Tilth has to do with all the major operations of soil manipulation. Microbes, under favourable conditions, attend to the oxidation, nitrification, and other chemical transformations which put crude organic substances into the plant food form; indirectly, with the acids "set free" (*sic*) by the decomposition of humus, and possibly by their own toxins and excretory products, they are also concerned with the "breakdown" and solution of the mineral elements themselves.

[1] Specially commissioned to investigate the *Nectria* disease in Trinidad (W.I.), and to report on the cacao cultivation of that island in 1907.

To give these microbes a "square deal"—in other words, to keep the soil surface fresh and moist, and at a more or less even temperature, to prevent wind-drying and sun-burning, to give the root-hairs on the feeding roots a chance to take their liquid nourishment in comfort and abundance—we must *mulch.*

It is a sad fact that only a small percentage of the producers of economic crops know, or even care to know, the prime functions and qualities of plant roots—that is, the very large majority of planters, and even horticulturists, do not use mulches. It is sad, because it means an unnecessary and unconscionable loss of probably about 15 per cent. of the normal production of the world's cultivated crops. And, putting the total annual value of all merchantable products of cultivated plants at about £5,000,000,000 sterling, doubtless an under estimate, the loss from the non-mulch system of the majority of agronomists is a matter of some £800,000,000 at least. It may be argued that this is not lost, that it is "left in the ground"; but this point needs no reply, it merely asks the question whether a *forest* soil would *outlast* a *bare* soil. In the subterranean battlefield where living matter must meet and try to devour the cold, dead grain of one-time rocks—there the questions of economy and ecology are left to fight it out. Bacteria and toxins, colloids and enzymes, antibodies, acids, a medley microcosm, all

somewhat affected by each, and all more or less successful in breaking down the mineral material into stuff that plants can make their ashes (skeletons) with: these factors, though plainly demanding both air and moisture that the good work may go on, are only too frequently neglected *in toto;* the meaning of the battle, the armies, the weapons, and even the results, are grievously ignored by the average agriculturist.

One half of the £800,000,000 lost yearly through ignorance and carelessness in attending to crop roots would not only pay for all the Government agricultural appropriations and all the scientific instruction along all the lines of theoretical and applied agronomy in the whole world, but would keep for five years a mulch expert in every farming district in every country, and establish, on five-year subsidies, 1,000 well-equipped institutions for plant growth investigations.

Until recent years the art of farming was ahead of the science; the planter did "thus and so" because certain methods were generally followed with good results. To-day the science, though only glimpsing the new light on the high points of modern agriculture's broad domain, is soaring above and beyond the mere art of plant production. To be sure, in some branches of horticulture the art seems more developed than the science; but even there the scientific foundation and framework

is being gradually demonstrated. The future oleraculturist will investigate the idiosyncrasy and inherited Mendelian characters of each variety before he puts it out on a large scale. The viticulturist's sons will keep an eye on their "cultures" in the handy-by laboratory.

A square deal for the roots! Protection from their enemies, the venomous grass-root excretions (that can make even a lusty orange-tree sick and choke the vigour out of the best stand of maize), the burning rays of the sun, the deadly soil-surface dryness; decent bed and board, *i.e.*, tilth and humus; give them these, and there will certainly come an increase of hundreds of millions of solid cash for the pockets of the planters.

If mulching were an expensive affair or difficult, there would be more sympathy for the losers. But the dust mulch is of the simplest preparation; the straw, or leaf blanket, is, except for the grain crops, almost always possible and profitable; the live mulch, or "cover-crop," is the triple-action modern implement which the farmer is beginning to wield very successfully in the soil-food-man war. If roots were only outside on the top, where the easy-going, well-meaning farmer could see them, he would then perhaps carefully note their symptoms and understand them. But, of course, being stuck into the ground, they are just anchors or props, and therefore

thoughts for their comfort—as when under the even coolness and moistness of a mulch where the microbes can multiply and the humus business hum—their very existence are practically forgotten.

Once on a cacao plantation belonging to one of the well-known English firms, the manager ordered a labourer from the dank, unsanitary recesses of the sodden field to demonstrate to me the good old way of "forking" the surface soil. After an embarrassing *quart de minute*, the perplexed fellow said, "I can't, boss; I not got my *cutlass*." Such things seem incredible, of course, but one can see, only too commonly, the root-murdering method in actual practice, just as one may see grass knee-high in coco-nut nurseries, or scorching hot white sand between the nearly half exposed seed-nuts.

To suggest a leguminous live mulch to the more advanced class of agriculturist is to meet with the objection that "there is only enough moisture, to say nothing of food, in the ground for the *primary crop*, and, besides, the blanket crop would hardly give back its own seed."

The vertical forking method, to let in air and food and break the clamminess of clayey or silty "packed" soils, which was first put before the Agricultural Society of Trinidad and Tobago in 1907, was hailed with gladness by perhaps half a dozen cacao planters and put into immediate, if but transitory, practice.

the beans up to 18 per cent.; sweet potatoes are also good, as they can be cultivated in deep rows, a good distance away from the coco-nuts themselves. The deep and thorough turning over of the ground which their growing entails is highly useful for the ventilation of the neighbouring coco-nut palms, it also brings with it the radical removal of the lalang grass roots. This item alone is worth a great deal, because the lalang is the most noxious weed on the whole plantation, and where it exists in any quantity the efforts in getting rid of it are often very costly.

With regard to sisal as a possible catch-crop, anyone thinking of planting this article on an extensive scale in conjunction with coco-nuts, or otherwise, should study an article published in German in *Der Pflanzer*, Nos. 17 and 18, of November, 1910, or the translation by Mr. Pape in *Tropical Life*, April and May, 1912. This deals with the utilization of the waste of *Agave rigida var. sisalana*, and the possibilities of making alcohol and sugar from the leaf refuse after the fibre content, &c. (about 4 to 8 per cent., leaving at least 92 to 96 per cent of refuse to be treated), have been extracted. Hitherto, considerable expense has generally been incurred in removing the refuse to a distance from the factory, where it can no longer create a nuisance. Although not a fattening fodder, cattle in Yucatan, we are told, get no other, whilst the writer of the article claims

to show that the quantity of sugar contained in the refuse justifies its being regarded as of commercial value. Pulqué, &c., made from the maguey, allied to the sisal, has been known for generations as an alcoholic drink. Fibre, alcoholic drinks, sugar, and feed cake, we are shown, can all be obtained from the sisal, but we cannot do more than refer to the article here.

Where catch- or cover-crops are not resorted to and where consequently the soil between the rows of coco-nuts is not disturbed to any great extent, the extermination of the lalang is well-nigh impossible. This grass trails its ramifications of roots for long distances underground, and if only a few pieces of them are left, they are sources of ever recurring mischief. The plants springing from seeds, which are blown from neighbouring lands into the plantation,[1] can be more readily taken care of by removal before they get firmly settled and deeply rooted into the ground, and this is best effected by turning over the ground continuously. The manioc or cassava is also deeply cultivated, and for this reason a good catch-crop, although its root-bulbs take a lot of nourishment out of

[1] See "Notes on Soil and Plant Sanitation on Cacao and Rubber Estates," 11s. post free (John Bale, Sons, and Danielsson, Ltd.), in which co-operation and even legislation is urged to prevent badly kept estates spreading harm around.

the soil it is grown in; therefore with rubber, those who can afford to establish their estates without interplanting tapioca, score in the end, because the trees yield quicker and more freely when grown alone.

The lalang grass not only forms tremendous root ramifications which owing to their felt-like consistency and thickness do not allow the water to percolate to the coco-nut roots, but in the dry season its dry stalks and leaves offer a most serious danger from fire. In a young plantation, where sufficient care has not been taken to keep it down or to eradicate it, the fires, which are even liable to start spontaneously, are apt to sweep through acres and acres of young growth. It is well-nigh impossible to check such a fire, especially if it is fanned by a high wind, and any young trees, which have not as yet reared their fronds well above the surface of the ground, will be irretrievably destroyed. Even if "fire-lines," *i.e.*, wide roads denuded of grass and other vegetation, have been provided around a plantation, they are not efficient safeguards, as the sparks are apt to fly over them and start a new blaze beyond. Nothing will provide a better or more certain insurance against fire than the total eradication of this pest. In some parts of New Guinea and in the islands to the north-east, the planters have tried, at heavy cost, to grub it up and plough it out; but ploughing between rows of palms

is, at times, a ticklish job. The best remedy after all is the cultivation of leguminous plants which will not only spread rapidly and prevent the lalang from coming up again, but will provide fodder for the domestic animals on the place, and return nitrogen to the soil.

The Mimosa family of plants, which are indigenous to most localities where coco-nuts grow, are among the most useful of these "cover-plants," especially on estates with cattle. The only drawback to them is the spiky nature of their leaves and stalks, which are apt to injure the feet of the natives and cattle, especially when the former are walking about among the stuff in search of the ripe nuts which have fallen to the ground, or doing other work about the estate.

The *Philippine Agricultural Review* for January, 1913, contains the report of the Director of Agriculture out there, in which various grasses and forage plants that had been planted experimentally are described, and their good and bad points discussed.

In this same journal we are told that the Army Board appointed to investigate and report upon the question of forage for the use of the Army, were also directed to consider the question of using, wholly or in part, native beef for the use of the Army in the Philippines. Those, therefore, planting up coco-nuts in those islands should secure a copy of this *Review* and study the contents.

For these reasons, whether it be to keep down lalang, or to counteract the financial disadvantages of the exceptionally long periods of waiting before the plantations can reach the profit-yielding stage, it is therefore desirable to plant catch-crops when they offer benefits in excess of their drawbacks.

A catch-crop should fulfil the four conditions laid down by Gallagher in his paper on *Coffea robusta*: It should not injure the main crop: it should yield a harvest as soon as possible: its cultivation should not entail any specially skilled labour: the preparation of the products from it should not require the employment of any costly machinery. To these may be added the obvious requirements that the crop should be readily remunerative—a condition that is frequently conspicuous by its absence with such of the Eastern crops as gambier, pepper and tapioca, the last named being, in addition, very exhausting to the soil.

Of all crops available for such purposes it seems probable that *Coffea robusta* most nearly fulfils the conditions laid down; soya-beans and ground nuts (*Arachis hypogæa*) perhaps coming next (see values, p. 17 and at end of book).

The main advantage possessed by this variety of coffee is, of course, its exceptionally early yield, for a crop of 1½ cwt. per acre is usually obtainable within two years of planting—this increasing threefold, to 4½ cwt., the next year, and threefold again, or to 15 or 17 cwt. per

acre, the following year.[1] At five years of age the crop would still be about the same, and the question of cutting out should then be considered, due regard being paid to the intrinsic value of the crops.

In the sixth and seventh years, as the coco-nuts come well into bearing, the coffee trees must of course be eliminated, unless there is exceptionally wide planting for the coco-nuts, such as 40 ft. by 40 ft. We know but little as yet as to the limits of development of *Coffea robusta*, but there seems no reason to suppose that with very wide planting there would be any danger of interference with the proper root development of the coco-nuts during the first seven or eight years of their life. Under the circumstances of planting advocated in other parts of this book, say 30 ft. by 35 ft. or 35 ft. by 35 ft., at least two, and we think three, rows of *Coffea robusta* might be safely planted between the coco-nut lines. We should consider the most advantageous system would be to plant three rows of coffee between every two rows of coco-nuts, themselves 35 ft. apart with 6 ft. between the coffee bushes—so that the distance between the outermost rows of the coffee and the coco-nuts would be 8½ ft.

[1] The Director of Agriculture in the Philippines, in his last annual report, writes: "144 plants of choice '*robusta*' from Java set out in 1909 have made a very vigorous growth and are now 130 to 180 centimetres in height with bushy tops. When one and a-half years old the trees bloomed abundantly. There is a good crop of berries about one-third grown at the present time."

Not later than the end of the fifth year after the planting of the coco-nuts, the two outer rows of the coffee should be removed, leaving the middle row to last out as long as might be thought desirable.

In connection with *Coffea robusta*, the planting of soya-beans should be considered. This is a legume which has come forward very remarkably during the last few years, although, of course, it has been planted in the Far East for centuries. As a catch-crop it completely fulfils Gallagher's requirements already quoted, and it has the additional advantage of considerably improving the soil in which it is grown by reason of its power to fix atmospheric nitrogen. Where cattle are employed on the plantation, the fodder provided by the green plant will be found invaluable. Such seed as may be left to ripen will be readily taken by the coolies for food, and if any is then left over, that again will be very saleable.. The great reason of success in obtaining a good crop of soya lies in the secret of inoculating the soil.

This has to be done either by transference to the new field of old soil in which soya has been grown, or by the use of pure cultures. Failing these, the only way is to grow two or even three crops of soya successively on the same soil until the ground has become self-inoculated. This soil may then be broadcast over new ground at from 200 to 300 lb. per acre, mixing it first of all with a larger quantity of ordinary earth so as to ensure even scattering.

If due care be observed, an excellent crop will be obtained, and the soil will be considerably improved by the planting.

Ground-nuts or, as they are sometimes called, pea-nuts (*Arachis hypogæa*) may also serve as a very remunerative catch-crop with coco-nuts, but care will have to be taken not to plant too close to the main crop, lest the necessary digging should interfere with root development.

The soil suitable for them appears to be of a sandy, loamy description, fairly light and porous, and not too dry. The average coco-nut soil would therefore suit ground-nuts admirably.

In the East the usual catch-crops made use of by the natives have been pepper, gambier and tapioca, and it is probably the use of these that has led to the frequent condemnation of all kinds of catch-crops by planters. There is no doubt that tapioca, in particular, exhausts the soil considerably, and the same is to be said of pine-apples, which are sometimes planted. The prices obtainable for pepper and gambier at the present time put them out of consideration except on the basis of the cheapest possible labour coupled with absolutely free land. Native squatters may, perhaps, make them pay, but hardly anyone else can do so, as the cultivation is practised at present. Meanwhile, soya-beans and ground-nuts being, in common with the coco-nut itself, mainly valuable on account of the oil they contain, attract the

same class of buyer, so that the one marketing does for all alike.

The correspondent in the *Mindanao Herald* (see page 94) touches upon the utilization of cattle on coco nut estates, and tells us that when the coco-nut trees have reached the age of two and a half years they will have reached such a height that cattle cannot injure the palms. This we consider over young; we should rather give three and a half years as the minimum, and, better still, four years. Unfortunately we have never been in the Philippines, however, and the palms may flourish their luxuriantly, and grow generally at a more rapid pace to start with than elsewhere; so we are ready to take it for granted that cattle can be turned in under the trees at two and a half years, and only warn the planters to see that whatever the age, whether two months or twenty years, neither grazing animals nor anything else be allowed to wander around and hurt the palms. To-day, possibly, with the more favourable cultivation and attention given to coco-nut planting, at any rate on paper and in reports, they may respond to the kindlier and more generous treatment and grow quicker; but, if so, they will be less tough and so more liable to attract attention from the cattle than were the ten-feet tall palmlets that we remember at three to four years old fighting for their spot in the sun, on sandy stretches along the seashore, or

even on the few estates then beginning to plant them. Having warned you, therefore, to look after your plants, and see they meet with no harm, we will go on to the question of cattle-raising, believing that we have here in many, if not in most areas, a valuable minor industry—"catch-crop," if you like—and even an equally important industry to take note of and rear up, side by side with the coco-nuts. We say this because cattle give at the same time their manure to the land, their labour to the estates as draught oxen, &c., and the value of their carcases, dead or alive, to the pockets of the owners. Pigs also deserve attention on account of the value of their meat when slaughtered, and the advantages of their manure whilst alive. Grazing cattle in the Philippines, our friend tells us, should be purchased and turned into the groves when the trees are two and a half years or more old—let us say, to be quite safe, when they have grown up out of harm's way. If this is done, the animals will keep down the vegetation, and add fertility to the soil. Experience of this character has been met with at Zamboanga, where experiments made resulted in the palms bearing at one to one and a half years earlier than when not grazed over by cattle. It was further demonstrated that such methods for fertilizing the soil of an old grove almost double the production of the trees. This being so, we can take it, therefore, that besides

the profit accruing from them as a side line, the cattle quicken the productive period as well as increase the yield when the palms have reached the bearing age. The cost of the cattle, of course, has to be taken into consideration, but in some places they are comparatively cheap.[1] In Trinidad, in the West Indies, for instance, we would tell you that with care and tact you could buy the half-wild Venezuelan cattle very cheaply, and bring them down from the mainland, by the boats plying regularly between the two centres, to your Trinidad estates to improve their weight and breed, and become eligible even for shipment to England, America, and elsewhere, where the retail price for meat has risen of late years to such an extent that all classes, except the really wealthy, who are comparatively few in number, are being seriously inconvenienced. Meat may be only one kind of food, but it is certain that if it fluctuates in price, other foods would follow more or less in sympathy; and in any case increased supplies would always sell well here if the quality was good enough. We maintain, therefore, that any estate, be it owned by one individual or by a company or syndicate, thinking of taking up coco-nut planting on a large scale, should seriously consider the whole question of running, let us call it, a cattle ranch and a

[1] See Mexican section, p. 155, Philippine Estimates, p. 95.

coco-nut plantation at one and the same time. Here, at least, we cannot be told, as with catch-crops in between rubber, that the subsidiary profit is only obtained at the cost of the main crop being thrown back and even reduced in size; on the contrary, with cattle as a "catch-crop" you hasten your returns and increase the output when they begin to come along. Above all, it will distribute your risks, and for once we do not think these two "crops" have any pests or ills in common that they can pass one to the other. In Zamboanga, we are told, 100 head of cows, with the necessary bulls, could be purchased in 1908 for $2,200. Prices may have gone up or down since then, but whatever the Philippine prices now are, they would only affect those islands. Planters in Mexico, Malaya, Trinidad, Jamaica, or elsewhere, in the West Indies or in East or West Africa and other centres, would have to work out their own bill of costs and gains—so we leave them to do so—but that it is worth trying we are certain.

Those interested in coco-nut planting in East Africa, who wish to try pig-raising as a side line, may be glad to know that local bacon experts recommend the following types of pigs especially for bacon curing: Berkshire, Berkshire crossed by Large White Yorkshire, Berkshire crossed by Tamworth, Berkshire crossed by Large Black, Large

White Yorkshire, Middle White Yorkshire, Tamworth, Large Black.

The bacon factory of the East African Estates, Ltd., shipped, according to the Nairobi *Leader*, 10,000 lb. of bacon to London by one steamer, and 7,000 lb. by another. Here, then, we have an instance of a good start having been made, thanks, it appears, to a good type of pig only being accepted at the factory. Seychelles pigs, whatever type they may be, were, we are told, refused, so must be avoided. The East African Protectorate exported copra to the value of £30,600 during the year ending March 31, 1911, and the area under coco-nuts, as well as the output of copra generally, was reported to be increasing.

Whatever class of stock you take up, make it a "speciality." Thoroughly analyse your natural proclivity and ask yourself in what direction you are likely to be most successful. In this connection, your early training and the capital at your command must be fully considered, but having once made up your mind, put all your energies forth to become a "specialist." It is an age for specializing, and the man who produces the best of anything is never short of a market. If a feeder, breed or buy and feed the very best. If a breeder of pedigree stock, do not attempt too much at first: select your breed or breeds, which should be suitable for the district, study their history and characteristics carefully, and

take every available opportunity of visiting the farms where the best specimens of the breed or breeds you have taken up are to be seen. This should prove of much educational value if intelligently pursued, and guide you in your future selection of animals to build up a name as a breeder of first-class stock. When buying foundation stock, start with a few of the right sort, rather than a large number of indifferent animals; and supplement your returns with commercial stock until you have grasped your subject and feel no doubt that you have properly gauged your inclinations and talents.

Much disappointment and money would be saved if more care and consideration were given to the adaptability of the farm and district for any particular class of stock decided upon, before embarking in it on any large scale. Making a commencement in a somewhat extensive way with unsuitable stock is certain to be followed by unsatisfactory results: this frequently sours and spoils a man's life, whereas if he had proceeded cautiously at the outset and felt his way gradually, success would probably have attended his efforts.

By adopting the slower and, in our opinion, the better system above recommended, the young breeder and feeder has opportunities of acquainting himself more intimately with the characteristics of the particular breed he has taken in hand, of forming an opinion of the best strains of blood and the most reliable sources

from whence to obtain suitable sires or females, as the necessity arises for the infusion of fresh blood, and of acquiring a knowledge of other minor points essential to ultimate success.

Again, when using cattle for manuring your crops, as on a coco-nut estate, remember that whether cattle or hogs, second and third-rate animals, especially hogs, consume quite as much as, probably more than, the very best, and the finished article is worth very much less : in the one case a profit can reasonably be looked for, whilst with inferior quality the result is usually a financial loss to the feeder. In other words, *all field produce realizes a much higher price per ton when fed to the well-bred stock* than when consumed by second and third-rate animals.

At a time when prices are booming inferior stock can probably be sold at good prices, but in a weak market only the very best makes money for the breeder, and the large prices paid for first-rate animals prove the difficulty of breeding them up to the highest standard of excellence, as Darwin well said. This is a point the breeder should never forget.

The demand from abroad for British pure-bred stock shows a healthy and expanding market, and the men who reap the richest harvest are those who give unfailing attention to all the details that make for success.

Comparing 1886 with 1906 the increased value in live stock exports from the United

Kingdom were as follows: Cattle, 259 per cent.; sheep, 456 per cent.; horses, 224 per cent.; the actual money value of the pedigree stock exported in 1906 being £1,883,849.

With the feeder, who generally is not a breeder of cattle, there is great room for judgment in selecting thrifty sorts, and knowing their market value. This power to see the finished article in the store animal cannot be acquired at once, but the feeder should leave no stone unturned to become possessed of the requisite knowledge. Experience will teach him much, especially should he be unfortunate enough to make one or two bad deals; but very often failure in any particular direction is the surest, and in some cases the only, way to drive home the important bearing the buying has on the ultimate financial result to the feeder.[1]

Meanwhile, according to Mr. Loudon Douglas, F.R.S.E., writing in the *Agricultural Journal* of British East Africa, on the swine industry: "The cause of the immense decrease in hog products is the universal scarcity in countries other than the United Kingdom, and notably in the United States of America. There the rapid increase of the population has curtailed the quantities of hog products available for export to such an extent that there is every appearance of this business ceasing altogether

[1] From a paper read by Mr. Alfred Mansell, of Shrewsbury, in 1909, before the Farmers' Club.

interested, so went to interview him and teach him all about the advantages o Venezuelan cattle. To our surprise we found that we had to be the student, for our new friend had been to Ciudad Bolivar, La Guayra, and other trade centres in Venezuela several times since we were there, and knew all about the Venezuelan cattle, their value, weight, &c. Those, therefore, who on this side wish to go into the matter need not altogether imagine that they must trust entirely to local cowboys; they will, like we did, probably find that they can pick up much valuable information as to what to do at the start, and along what lines to proceed, and having ascertained this they can then make further inquiries abroad. Take the Venezuelan (or Zamboanga) cattle as an example of what we mean. The cattle here should run about 800 to 1,000 lb. dead weight; those from Venezuela ran only up to 600 lb. as a rule, and therefore were no use to this trade. To increase the weight you must pen the animals in, wild habits beget lean shanks; feed well, and import, to the utmost of your finances, good bulls to increase the weight of your calves. Do not run one such bull among 5,oco or even 500 cows, as has been done, or else you will be greviously disappointed with the results. Ascertain locally, or, better still, from the breeder or owner from whom you buy the bull, how many cows he should

be allowed to cover in a year, and having ascertained that, keep him to such a number and no more. This done, take note of your calves, turn the indifferent ones out with the herd, but keep back the best bulls to breed only with the best cows, and have patience. In a few years, by the time, say, your coconut trees are in full bearing, you will have a fine herd of picked cattle, the weight of which, helped perhaps by fresh arrivals, will soon come up to that necessary for the English trade. Meanwhile, cattle and meat are always saleable locally.[1] Whilst you are

[1] The following paragraph, taken from Mr. Acting-Consul Crosby's report on the trade of Bangkok (Siam) for the year ending March 31, 1911, shows that coco-nut planters in the Straits Settlements and the Federated Malay States would also do well to take up cattle rearing on their estates: "The number of bullocks exported (3,022) is nearly five times as great as in 1909-10. It is much to be regretted that the cattle-rearing industry, once a flourishing one, should have dwindled to such miserable proportions of late. Siam offers good facilities for cattle breeding, and excellent markets are to be found in the Straits Settlements, the Federated Malay States, and the Philippine Islands. In-and-in breeding, with its consequent reduction in the weight of animals and their greater liability to sickness, is mainly responsible for the present conditions. It should repay the Government well to organize measures for the control of breeding, the importation of fresh blood, and the stamping out of contagious disease."

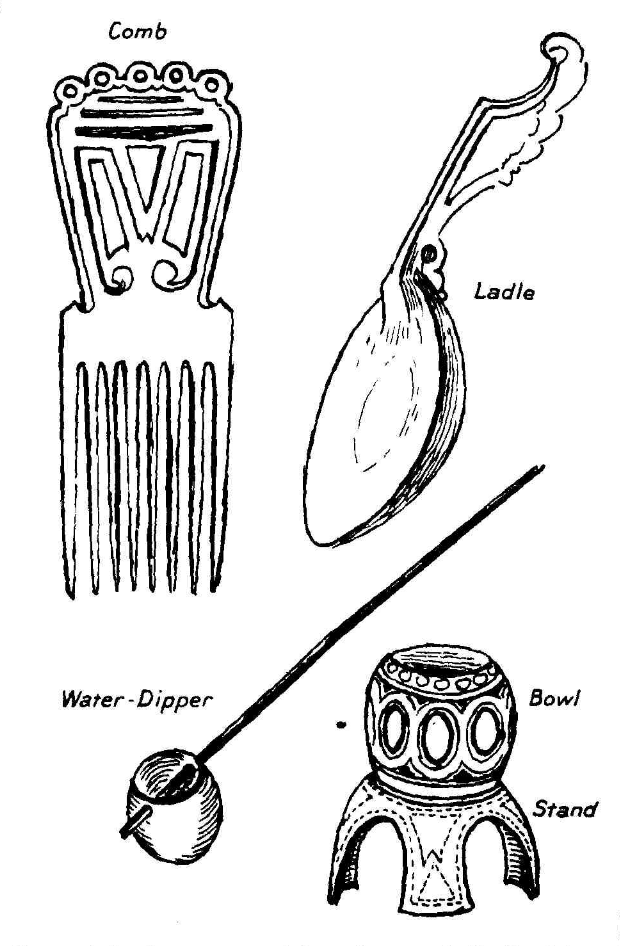
In May, 1912, the wholesale trade in London owned that prices, both of beef and mutton, stood higher than for many years, and must continue abnormally high for some time.

building up and increasing your herd you must be interviewing the steamship owners and arranging for the transport home of the meat (do not ship live cattle) and for their giving you cold storage, &c.; making these arrangements ahead will enable you, when ready, to launch forth without delay or loss to anyone. Of course there is much to be done, but there are also years to do it in, and it is wonderful what you can do in ten years *provided* you know at the start that you are going to do it. For these reasons, therefore, we suggest—and it is only a suggestion, for we cannot now give more reliable data and figures—that every would-be planter of coco-nuts on a large scale should consider the matter and sum up the costs and profits, the *pros* and *cons* of breeding and fattening cattle, hogs, &c., on their estates before casting the proposal aside. Of course the idea refers only to such estates as have or can grow the necessary herbage, and where the owner can get the cattle down to the port at a remunerative price and in good shipping order, not heated and fagged on account of a forced march overland. When such conditions do exist, as they do at several centres, planters can seriously consider the question of utilizing cattle as a permanent "catch or subsidiary crop" on coco-nut estates.

THE DEMAND FOR COCO-NUT PRODUCTS.

HAVING caught your goose, otherwise having produced your coco-nuts, it may be just as well to think a little about the various uses the products can be put to, so that the up-to-date planter, instead of wasting any chance side-line, can develop them and utilize every atom of by-product on his estate. It is an old story to tell of how everything attached to the coco-nut palm is of use, wood, fibre, leaves, husk, shell, kernels, oil, poonac, &c. Nothing need be wasted, each portion is in demand and wanted somewhere, and it only remains for the planter to ascertain where that somewhere is. We will do our best to try and help him do so.

As in the stockyards at Chicago the canners and packers have brought the question of the utilization of "waste" to such a fine art, that we are told their enormous fortunes come from this item alone, and not from the main lines of their business, so will it be found on large coco-nut estates, that whilst the profits need not only come from "waste lines" and by-products, the organized exploitation of them will help to considerably swell the dividends. After being spoiled by the huge rubber



Domestic Implements carved from Coconut shells.- E. Africa.

dividends promised, and realized, those trying to raise capital for planting up coco-nut lands will find it necessary to enlist all these side-lines into their service, in order to get the increasing and more elastic dividends without which the public will not come in ; they will jump at a rubber estate without trees, or a gold mine without gold, because here and there similar ventures have paid enormous dividends, and yet pass by a coco-nut planting proposition with a certain 10 per cent. to 20 per cent. dividend as being unworthy of their attention. We say this as there is no doubt it was the spirit of speculation, the mad hope of making £50 out of £5, or even out of 5s., that caused the mad rush after rubber shares that took place in 1910 and 1911. If you find this difficult to believe, attend the meetings, especially of the Trust Companies, and ask the directors, as we have done, why they do not exercise their powers and plant rubber, instead of only speculating in shares. You will get your answer, not from the directors, but from your fellow shareholders, who will stand up one after the other, and tell you point blank that they have not taken shares to plant and wait years for a big dividend, but to join in the gamble. On this account, although no dividend is declared, only heavy losses shown, with very low quotations for your shares, there is nothing that seems to attract the public like a Trust, as those trying to float coco-nut options find to their

cost. At the present moment, even rubber companies are indigestible, whilst those having coco-nut options, and really good ones, find that their offers meet with no better response than comes from the sea-sick passenger when hailed to a choice dinner by the ship's steward. No matter how choice the dinner, the answer is sure to be the same.

This, however, does not say that coco-nuts cannot and will not pay, and pay well. It may only be a 10 per cent. or 20 per cent. dividend; but such a dividend on a well managed and well planted estate is assured, and if it will not grow into 200 per cent. at least it is always there once the trees come into bearing; and in any case the success of the estate is not so dependent on a large supply of labour as rubber is, and always must be. We would further maintain that present rates of dividends can be added to, and this and subsequent sections will be devoted to showing why and how this can be done.

Roughly speaking, of course, apart from palm-wine, there are five main products for export to be obtained from the estate, viz., nuts, copra, oil, desiccated coco-nut, and coir yarn, although we believe as many as eighty-three different products are claimed to have been found[1] suitable for trade and commerce in connection with the coco-nut palm. If this is so, there are still hopes of new in-

[1] See Pereira, quoted in "Watt's Dictionary," ii, 456.

dustries being discovered besides the five just mentioned, and certainly no one will deny that with the scientist on the field, the plantation coco-nut industry may yet discover other important lines for earning increased dividends. Mr. William S. Lyon, when in charge of the division of Plant Industry in connection with the Philippines, included the following items in his now well-known Bulletin, No. 8, on "The Coco-nut." The husks are exceedingly rich in potash and phosphoric acid, so their value as manure is considerable, although where possible to turn them into fibre the value of the husks is wasted if used as manure; the leaves and midribs, when burned, furnish an ash so rich in potash that it may be used alone in water as a substitute for soap, or when a powerful detergent is required. Fibres are not only confined to the husks; from the tough midrib of the leaf, strong baskets are made, also excellent and durable brooms, whilst pot-cleaning brushes can be obtained from the part where the midrib coalesces with the petiole. The "milk" again, at present we believe entirely wasted, could, when obtainable in large quantities, be utilized for making vinegar, if not for making a fermented beverage, as in the manufacture of wines, spirits, &c. All this is still in the experimental or home industrial stage, where comparatively small quantities only are used, but when it comes to a matter of two or three million nuts being

"Sweets from the Sweet."

The milk of green coco-nuts is one of the most refreshing drinks imaginable on a hot day.

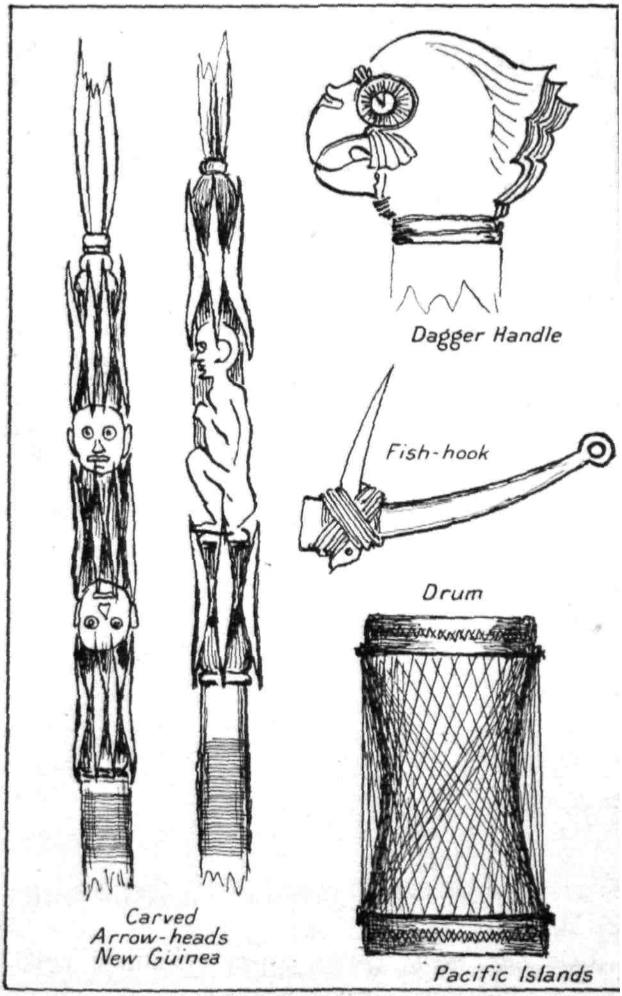
collected together at one or two factories, the possibilities for the discovery of further uses are increased. We remember, for instance, a firm on this side which was turning out a really good felt from the "fibre-dust" for use under carpets, but had to give up making it owing to its inability to secure the raw material. Had the patent, however, been worked on a large coco-nut estate, the supply would have been assured, and the cost of the "dust" after the extraction of the fibre would have been as nothing, since no freight and charges would then have to be taken into account, as is bound to be the case if the felt is made up in Europe or America. We mention these items as we think of them, but there are others, and we have no doubt that once plantations of coco-nuts come into existence equivalent to and as well capitalized as the good rubber estates are, the question of by-products will not be lost sight of, but, on the contrary, become the object of special study and attention.

In the *Philippine Journal of Science* for June, 1911, Mr. H. D. Gibbs includes the following products arising out of the palm :—

The Palm gives (1) nuts, (2) trunk-wood, (3) leaves, (4) flower-spathe.

No. 1.—*The nuts* give (*a*) meat, (*b*) water (*c*) shell, (*a*) husk.

(*a*) *The meat* gives copra (yielding coco-nut oil, from whence come soap,



ARTICLES MADE FROM THE COCO-NUT.

candles, butter, lard, ointment, cooking and illuminating oil, oil-cake for cattle and chicken food, and for manure) and desiccated coco-nut: also tagalog, a food product made from the juice or milk expressed from the fresh meat.

(*b*) *Water* yields a beverage and vinegar.

(*c*) *Shell* — rubber-tapping cups, bowls for many uses, house utensils, carved articles, fuel.

(*d*) *Husk*—coir-fibre for ropes, twines, matting, carpets, brush and broom fibre, caulking, and always fuel.

No. 2—*The wood* is good for cabinet work and canes, for building, and for fuel.

No. 3—*The leaves* are good for basket-making, thatching, screens and partitions, mat-making, midribs for brooms, and the young leaves (also the young stem tissues) for food.

No. 4—*The flower-spathe* yields syrup, palm sugar, fermented drinks (toddy or tuba), distilled beverage (arrack or wine), vinegar.

A large, well-organized estate, therefore, can develop many subsidiary industries in order to utilize every waste product, and so increase its profits.

Going back to the five main items we would say that the shipment of copra, or of the husked nuts, must, for some time at least, be the chief industry. The nuts, where there is a market near enough to take them at a price that does not make it worth

one's while to trouble about copra, as with New York, and Panama and the West Indies; and copra, as in the South Seas, the Philippines, Southern India, &c., where distance and the quantity of the nuts produced cause the making of copra to come first. As regards oil, this is an industry at the producing centre which at present shows no signs of being of prime importance, unless there is a local demand to be satisfied, as it seems generally accepted as being easier, if not more advantageous, to ship home the copra and make the oil at the large consuming centres in Europe and America.[1] But the question of freight, and (let us add without unreasonableness in these days of huge combines) a stray chance of the vegetable-oil producer following the lead of the petroleum shippers, and shipping his oil in tank steamers may yet cause oil and not copra to be the main article of export, especially from the Philippines, where, according to Mr. O. W. Barrett, there are already 33,000,000 trees, so that a billion[2] nuts should be there for export. Therefore the shipment of oil in bulk may yet come, although at the moment it is not feasible. Here, again, is where science and organization can turn an indifferent dividend into a substantial one. On a large coco-nut estate, with,

[1] Coco-nut oil has entirely disappeared as an export from the Philippine Isles.—Consular Report for 1910.

[2] An American billion is, we believe, 1,000,000,000.

say, 5,000 head of cattle or pigs, it would probably pay well to turn all the copra into oil, if only to obtain the poonac for cattle feed. The value of this by-product is rapidly increasing. Coco-nut meal is becoming recognized as a concentrated feed of high value, and as an organic fertilizer equal to cottonseed meal. Again, dairy experts in Australia, the *Agricultural Journal* of British East Africa tells us, state that the use of copra cake is most beneficial in keeping cows in excellent condition, and in maintaining the milk supply at profitable levels. The best feature of the feed for the Australian dairy farmer is that the ration can be nicely adjusted to the supply of grass in the pastures. If milk cows are heavily fed while they are running on good grass, the actual return from this cake is less than when the hand feeding is so adjusted as to supply what is lacking in the grass. If long dry spells of weather occur, as are frequent in Australia, the milk supply of a cow feeding on natural grass alone may decrease from perhaps 12 quarts to 6 quarts a day or less; if the deficient grass diet is supplemented by oil cake the normal supply is again forthcoming. Thus the demand for such cakes varies greatly with weather conditions affecting the natural fodders. The use of copra cake in connection with poultry raising in Australia is also increasing, as it apparently results in a gain in egg production.

The tank steamer would then sail with the various fibres and the oil only (*i.e.*, no copra or nuts), together with a cold chamber for the beef, hog products, poultry, and may be edible coco-nut butter, as well as refined or jaggery sugar, made by the ton for consumption in the temperate countries. Who can say, therefore, what limitations the future has in store for us when brains, capital, and organization come together to run the coco-nut estates in friendly rivalry to plantation rubber, each side seeing which can, in the end, pay the best regular dividends on every million sterling invested? We should not be surprised if the coco-nut companies, taken as a whole, won, although, of course, the dividend of certain picked rubber estates might probably far exceed that paid by any individual coco-nut plantation.

COPRA AND ITS PREPARATION.

Now, after all due care has been observed with reference to the judicious selection of the site and soil, the proper choosing of the seed-nuts, the most advantageous planting out and expert care in looking after things steadily and continuously, and when, in its full time and season, the plantation has been brought to maturity, it is expedient to go to work and prepare for the best mode of "making up" the copra. Copra is the nut-kernel or meat of the coco-nut in a more or less thoroughly dry state, so as to render it fit for shipment to the over-sea markets. Only sun and mechanically dried copra are fit for making into oils, for human consumption, especially for confectionery purposes. Fire-dried copra is for soap and candle manufacture only. There are three methods employed for preparing copra for shipment, viz., first, the crude and original native way of drying the kernels by means of the tropical sun, either on the ground, on barbecues, or on drying racks and hurdles with provision for roofing in wet weather; secondly, on split bamboo hurdles or on grills over fires; and thirdly, the artificial way (introduced by Europeans) of drying the kernels

independently of the sun, by means of hot air in a properly constructed oven or other mechanical appliances, or in buildings or rooms specially designed for the purpose.

In his *Farmers' Bulletin*, No. 17, on coco-nut culture (Bureau of Agriculture, Manila, Philippine Islands) just to hand, Mr. Barrett includes useful information and instructive illustrations of the rearing, harvesting, and preparation of coco-nuts and coco-nut products. His first photographs of a typical plantation at La Laguna, show at a glance, by the closeness of the trees, why the production on some, and most of the estates there, is so small.

In the matter of drying the copra, of which the Philippines now claim to be producing about one-third[1] of the world's total crop (and this percentage is likely to increase in the near future), we are warned that it is highly advisable that steps should be taken at once towards the general adoption of artificial dryers in place of the present methods of sun-drying and smoking over the tapáhan.

The disadvantages of the sun-drying process, points out Mr. Barrett, are: It can only be used during the dry seasons, which in most parts of the Philippines are of more or less

[1] The present crop is valued at P. 20,000,000, but with proper cultural methods it is calculated that the same area could easily export P. 25,000,000 (P. = Philippino = 1 yen or 2s. 0½d.).

uncertain duration ; the time required is excessive from an economic standpoint, and the drying is not sufficiently rapid to prevent decay in the copra from nuts that are more or less immature when picked.[1]

The disadvantages of the fire-drying process are : The creosote and other substances carried in the smoke from the husks and shells permeate the entire mass of the copra meat, thus rendering it unfit for the higher purposes for which the unsmoked article may serve, such as butter, edible oil, &c. ; the drying is always more or less uneven, some of the pieces being scorched while others are scarcely half dried at the time of removal ; moulding and decay, while *en route* in bags, are very likely to result from the half-dried copra pieces, which are always sure to begin to decay within a few days after their removal from the tapáhan. Against these the advantages of the modern artificial methods are : the absolutely smokeless quality of a well-finished product ; the small amount of time required for turning out a completely dried article ; the far better keeping qualities on board ship or in store ; the very superior appearance of the artificially-dried material, its freedom from mould, dirt, &c. ; all of which are almost always to be found in the sun-dried product.

[1] The nuts of course should not be unripe ; at the same time, as with the cacao planters in Bahia, the Philippines must, in the end, adopt mechanical dryers.

In spite of opinions and reports to the contrary, including those mentioned in several places in this book, it roughly takes three nuts to make 1 lb. of well-dried copra; therefore, until improved cultivation permanently increases the kernel-content of the nuts far beyond what it now is, taken on the average, drying space for at least 6,000 nuts—and 7,000 would be the safest number to reckon on—must be allowed for in any drying appliances erected for every ton of copra to be turned out. It is maintained, and we believe with perfect correctness, that 4,000 nuts from carefully planted and highly cultivated estates, are all that is needed to make a ton of copra, as "compared with the 6,000 to 7,000 nuts grown on native lands." This is doubtless correct, but as the large highly cultivated estates turning out 2,000,000 nuts and over in a year have still to come into maturity, we are bound to go by the majority of outputs, and 95 per cent. of these go from 6,000 to 7,000 nuts. The words put in inverted commas just above were taken from a report of a great believer in 4,000 nuts to the ton, who, in using them to prove his case, confirms what we claim, *viz.*, taking the producing world as a whole, that 6,000 nuts at least must be reckoned on. In discussing coco-nuts in Samoa, 7,000 nuts are also given as being necessary for one ton of copra.

There is one consolation in this matter with

self-sown coco-nuts, as with cacao. If your produce is larger and finer, and therefore of higher commercial value than your neighbours, not only will the yield tend to be less, but your trees, pampered and cared for like the spoiled children that you wish to make them, are inclined to become less prolific and more tender and liable to disease in all ways. It has still to be seen whether the rough and ready trees of the natives do not, in a term of years, give as many tons of copra—or, let us say, give as much, or even more value in copra—as the more highly cultivated and regularly planted estates of the European. You cannot have everything, and although we are strongly averse to indifferently cultivated estates, at the same time we do not wish our readers to be disappointed. A glance at any comparison of fine *Criollo v.* ordinary *Calabacillo*, or even *Forastero* cacao, or, in cotton-growing, Sea-island *v.* American upland or Marie Galante, will at once illustrate what we mean as to yields tending to decrease as the quality is improved. With care, chances of disease can be minimized, and cultivation assures an equable output, increasing the quantity and improving the quality of the product. But it has still to be proved how far large estates can successfully compete with native-owned areas for extended periods, say for twenty-five or fifty years.

Coming back to the preparation of the

copra, experience shows that the first or native method does not ever give a thoroughly satisfactory result, except perhaps in localities where one can invariably depend on a cloudless sky with fierce mid-day heat for weeks on end, and even then the copra can never be reliably dried, but will be found to contain a percentage of moisture varying from, say, 6 to 19 per cent. This presence of moisture in the copra accounts for the forming of mould, and is, of course, a serious drawback, as it militates against the obtaining of a good price for the product, to say nothing of the possibility of its being a grave deteriorating factor of the quality, causing the entire parcel to be rejected. This mould[1] naturally gets worse as time elapses, and the longer the copra has to be stored before being shipped and until it reaches its destination in Europe or America and is actually used, the worse it will become.

This set-back applies naturally in a lesser degree to places like Malabar, Ceylon, or to any centres where there are oil mills and vast desiccating establishments on the spot for carefully dealing locally with fresh kernels and the copra within easy and speedy reach of the plantations. But the majority of planters are not so fortunately situated, and it is for this reason that oil may supersede copra as an article of export in the future, especially from

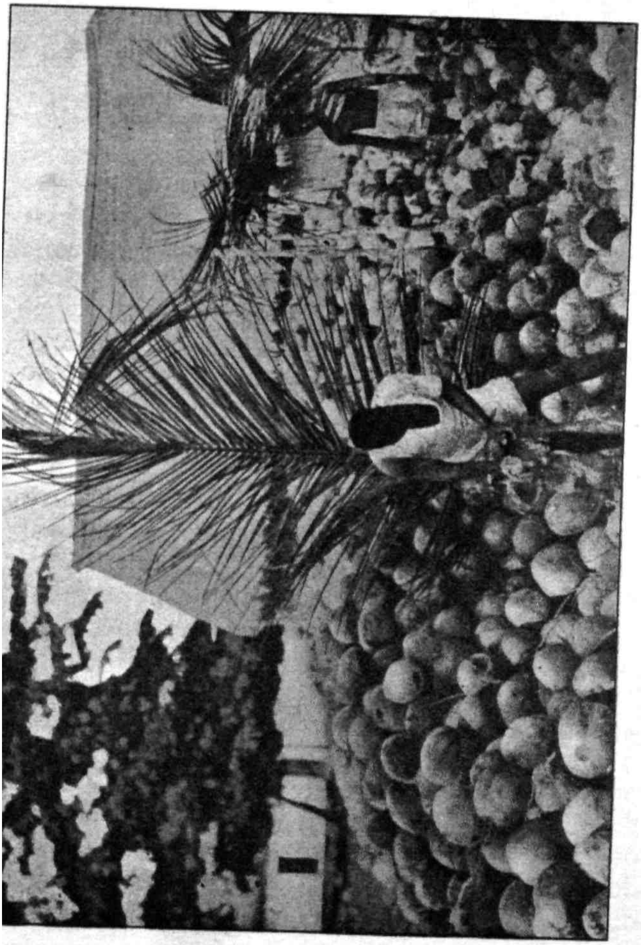
[1] See p. 54, *re* the reason of mould forming in sun-dried copra.

large producing centres, if trouble is experienced in drying the meat.

Since the acquisition of the Philippine Islands by the United States, their excellent Department of Agriculture has carried on investigations in that region for the especial benefit and encouragement of its staple products, of which the coco-nut is recognizedly one of the most important and widespread,[1] with the result that many of the main problems of that industry have been closely studied, and for the greater part definitely solved. It has thus been found that in order to obtain a copra which will be free from the tendency to form, say, 10 per cent. mould, it must not contain a greater percentage of moisture than 5 per cent. The more thoroughly (*not* the longer period) the copra is dried the less fatty acids does it generate or retain, and this has a great deal to do in reducing its liability to become rancid. It must also be borne in mind that the moisture contents of copra, the same as maize, &c., can be added to between the time it is dried and used. Allowance, therefore, should be made for this as well.

Tests made by the *Philippine Journal of Science* of Manila clearly show that the artificially dried copra always has an advantage over the sun-dried article to a remarkable degree, viz., copra dried in 51-56°C. (immediately after opening) contains after a process

[1] See Barrett on "Coco-nuts in the Philippines," p. 358.



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HUSKING COCO-NUTS BY HAND IN THE PHILIPPINES.

of about twenty hours, ·08 per cent. of free fatty acid, and copra dried in from 50-93° C. for a period of four to fourteen hours (this copra had been opened and left in the ordinary atmosphere for twenty-four hours), a percentage of ·30 to ·60 per cent. From the same source also we quote the following tests made with coco-nut oil regarding its percentages of free fatty acids :—

Oil from copra dried under shelter, at 80-90° C.	·06 per cent.
Oil from copra, sun-dried	·13 to 3 per cent.
,, ,, heavily mouldy ...	1·18 ,, 3·5 ,,

All these arguments and statements go to prove that the primitive native method of drying copra has no chance against the artificially dried one, even taking into account the cost of erecting more or less elaborate establishments for doing so. When all is said and done, the cost of setting up drying-kilns is not at all prohibitive, especially if the area of the estate is extensive, and where the quantity of produce to be treated renders rapid and up-to-date methods for drying imperative.

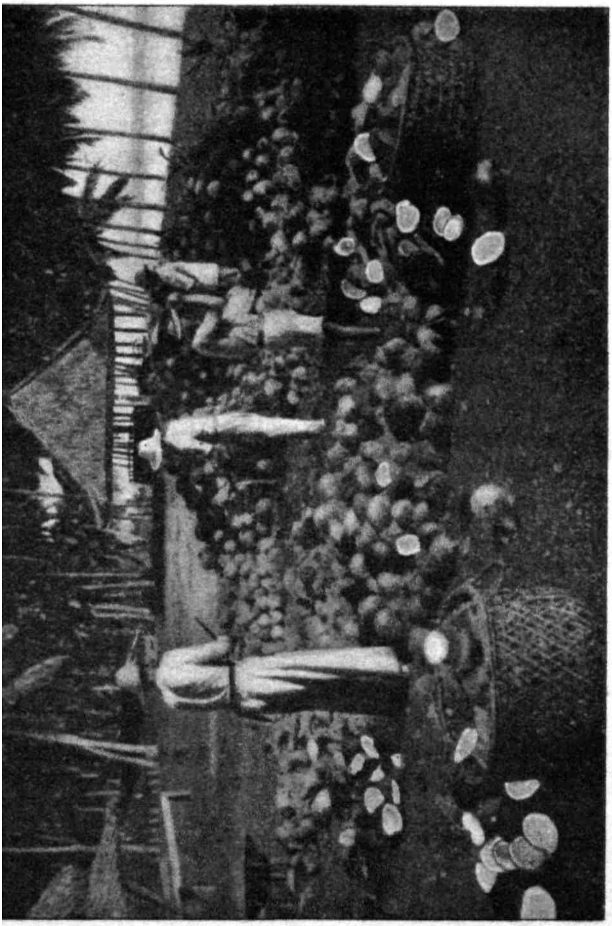
The finest, most desirable, and highest priced copra is that which yields a clear, white oil, free from fatty acid, pleasant and smooth to the taste, and having no pungent and acrid smell. The producers on the Malabar Coast, who have been established there for very many years, have by dint of much devotion and energy succeeded in putting on the market

an almost perfect product, even when prepared in bulk, and almost wholly free from deleterious substances, which therefore rightly commands the keenest competition and the highest prices. Going to the other extreme, the South Seas and part of the Moluccas produce the worst and lowest priced article. This is mainly due to the preponderance of careless native preparation in those parts (the same as with cacao planters on the West Coast of Africa, in Haiti, San Domingo, &c.); but the time is fast coming, as the white man spreads his interest and holdings over those far removed regions, for all these drawbacks now existing to be eliminated and gradually disappear.

Although the good old days of "trading" on the quarter-deck, with identities and terrors like strenuous "Bully Hayes," "Yankee Ned," and "Dirty Dick Johnson," have gone never to return, there is still a good deal of inter-island trade by means of schooners and other small craft afloat. In the old buccaneering times referred to, when the trader hove in sight, it meant either copra or muskets to the hapless Aborigines; the quality was not of so much account as the quantity to be taken to the shipping centres. Nowadays, all, or nearly all, these "persuasions" have disappeared, as the market for one thing demands a better product, and the various Governments concerned keep a sharp eye on all over-riding and harsh delinquencies, which are invariably visited with dire penalties.

Another great and potent factor for betterment is the establishment of regular lines of coasting steamers to visit the labyrinth of island groups much more frequently and extensively. On many even very remote islands, Europeans have established themselves recently, and are devoting their time and energy with varying success to coco-nut planting. One by one, therefore, the unproductive or neglected spaces of the wide world tend to disappear, and the centres from which supplies are available increase in number and extent. At the same time the goods must come to market, so the European, at least, if not the native, must see that he does not have to spend too large a proportion of the price obtained in transport. In some cases, several months, or at least weeks, must often elapse before the planters can hope to get their produce to market, and costs in such cases must be excessive. Under such circumstances it naturally behoves the individual owner or manager to avail himself of the best and most advanced methods for preparing his copra, in order to put it on the market in the best condition possible, so as to assure his obtaining the highest price for one thing, and also to create for his product a favourable and steady demand. All of this is quite feasible with proper circumspection and care.

In some centres, to a great extent, the demand for the nuts themselves for export, as



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HALVING COCO NUTS IN THE PHILIPPINES.

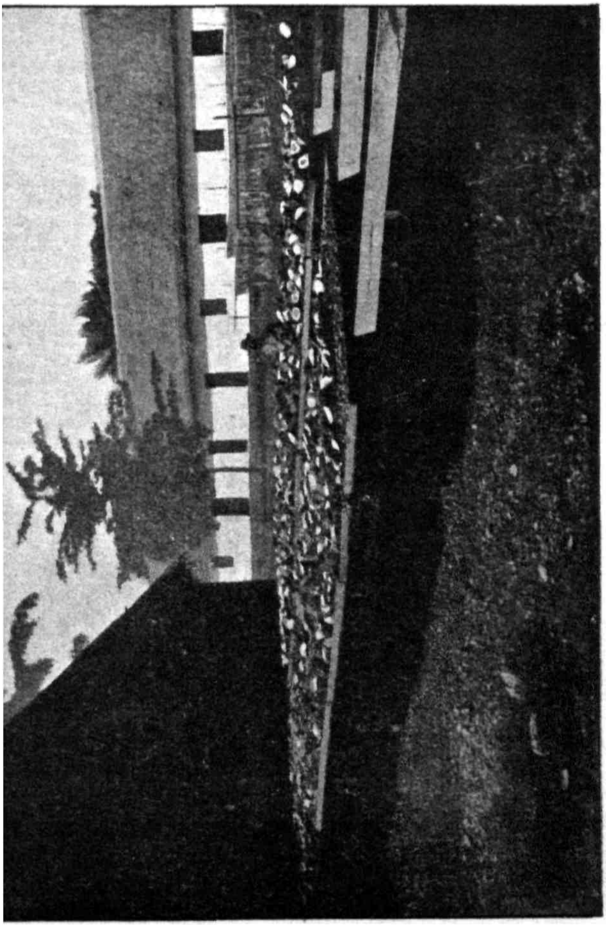
in the case of the West Indian Island of Trinidad, which practically ships all its nuts to the United States, renders the planters exempt from the trouble of drying the copra or of making oil. Local consumption, again, as in China, India, Burmah and Siam notably, absorbs annually many millions of nuts; therefore, when buying your estate, ascertain which will pay you best—to sell the nuts whole, to make copra, desiccated coco-nut, or oil and poonac.

After being halved, Mr. Worcester tells us, the nuts are placed in the sun, concave side up, and the meat as it dries separates from the shell. Meanwhile the milk, which in the aggregate, as shown in the tables on p. 526, weighs almost as much as the meat itself, goes to waste on the ground.

On p. 374 we have trays, as used in San Thomé and the West Indies for cacao, which are pushed under cover at night or when it rains. When the meat, as described above, is ready to separate itself from the shell, the nuts will be removed, the shell carried away to be burnt, and the meat will be completely dried by itself.

On p. 377 it will be seen that the halves are being placed over the grill for the preliminary drying, previous to removing the shell. We leave our readers to imagine the state of the meat when shipped.

The phenomenally rapid opening up of the vast Empire of China alone by railways and



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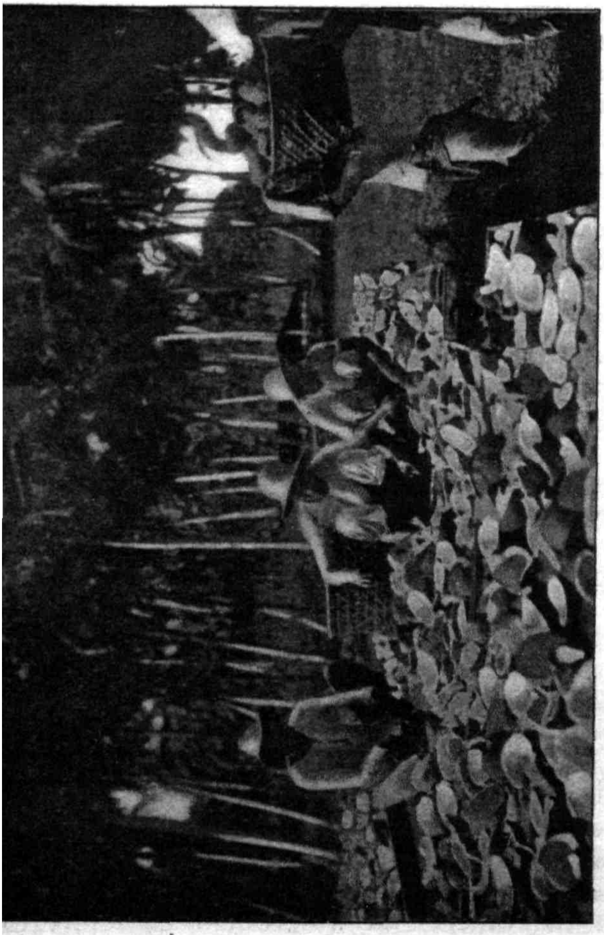
HALVED COCO-NUTS, STILL ATTACHED TO THE SHELL, BEING DRIED IN THE SUN.

steamer communication should spell increased prosperity and much more demand for coconuts in the immediate future. For the *Cocos nucifera* is one of the main food staples of the East, and of the possibilities of its consumption there is no ending.

A good many of the proud sailing ships of a couple of decades ago now only fulfil the prosaic mission of an inter-port trade from the coco-nut growing lands and isles in the "belt" to the adjacent regions beyond. One comes across these proud ones of a bygone day in every creek and corner of those latitudes, often captained and manned by natives. The handling of the nuts is very cheap, and so indeed is the whole traffic; it is, therefore, a useful agent and medium even for the European planter who happens to be so fortunately placed as to be able to avail himself of it to advantage. The safety or otherwise to the rest of the shipping is quite another matter, and collisions and wrecks galore are the rule and not the exception. It is always wise to give such "country-wallahs," as they are called, as wide a berth as possible, or they are apt to make rather free with one's hamper. It is quite a common sight to see them try to lay alongside and board each other in the open sea, just because Moussa, Ibrahim, or Wan Feng happens to have a brother or something on the other craft with whom he wants to swop lies or exchange and "makan-sirih" (eat



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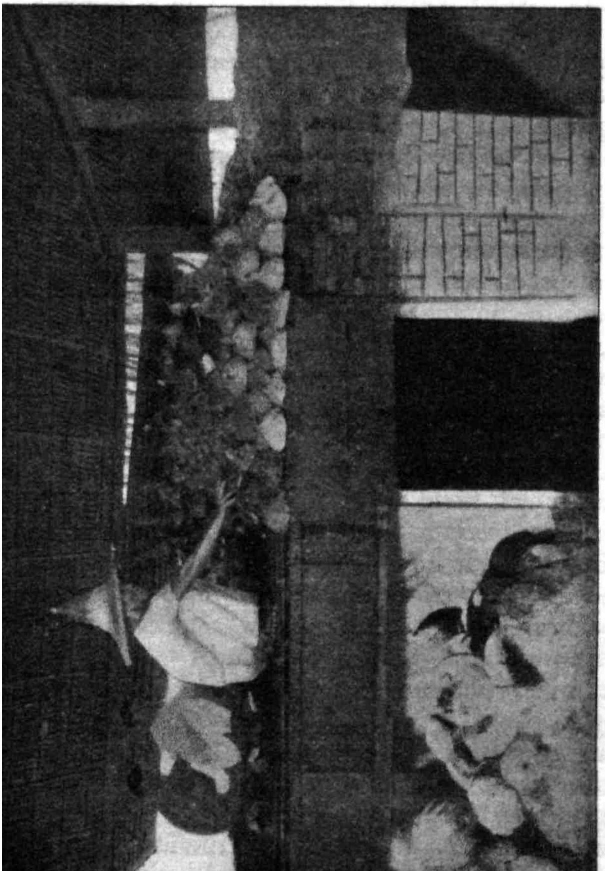
THE MEAT, SEPARATED FROM THE SHELLS, BEING DRIED IN THE SUN ON TRAYS.



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KILN OR TAPÁHAN DRYING, *i.e.*, DRYING COPRA ON HURDLES OVER A SLOW FIRE.

betel-nut). As for the loss of time, that is no matter; those fellows have plenty of it always. As long as the sea is fairly smooth it is generally all right, but with a heave on it frequently means dipping into the repair account for rigging, braces, and stays, and often worse. Once on a trip from Pontianak, Borneo, to Singapore, in a small schooner-yacht, we had the misfortune to fall foul of one of these customers lying becalmed several miles distant from us nearly all day. After nightfall the breeze freshened, and a thick and squally night, too, brought the "country-wallah" with it down on the top of us. As is common in those waters, the squall brought her along with a rush, before we could get decent headway on. Our crew saw her coming through the thick murk, heading straight for us with every stitch set driving before it. We sheered away, trying to clear her, but she altered her course, drawing after us again. She was a big lump of a brig, and seemed to tower heavens-high and to be going like the wind. There was not much time to lose. Fortunately, one of us was possessed of a fairly good-sized, quick-firing gun which fitted on a bollard aft. This was brought to bear right where we calculated the topsail halyards to be and let go, and although it did not bring down the sail it made them luff hard, because that report was no "whisper faint and sweet," and at any rate it certainly saved the situation. We learned

afterwards that our serang (boatswain) had a close friend on that brig who thought it was a good chance to pass the time of day.

After this slight digression to touch upon one interesting phase of the industry which is conducted under so many different circumstances and amenities, let us "return to our muttons."

We now come to the subject of the artificial preparation of copra either by means of heated air under a roof, in a building especially contrived for the purpose, or by other means.

Without doing more than noticing the attempt made by some French planters on one of their islands in the South Pacific to dry copra by means of steam-heat, because for various reasons it was not attended with any signal success and the system was abandoned, we will discuss some of the patterns of hot-air drying houses in use, the main features of which are a furnace, a system of wide sheet-iron pipes with high chimney stack for a good draught, and a wooden or corrugated building set upon the masonry wherein the afore-mentioned furnace and pipes are contrived. Herein we find placed vertically over the pipes a series of trestles, one above the other, to hold a dozen or more hurdles of a given surface space and capacity, and, horizontally extending beyond the pipes and hurdles on three sides, an ample, covered-in floor space upon which may be spread the hot

copra as it comes off the hurdles from over the heating pipes. It is very essential that the copra be well cooled off, in a gentle draught of the ordinary atmosphere and all the remaining moisture eliminated before being shipped. If an even heat of 50° C. be maintained in such a drying house for about twenty-four to twenty-five hours, the copra will then be found all that is desired.

Care must be taken that there are no big surfaces of boards or beams immediately over the copra on the hurdles, for the evaporating moisture to settle upon and fall back in drops upon the copra, for this will cause bad discoloration of the product and consequent depreciation of its value, for if the copra is to realize the best and highest prices, it must be kept as white and uniform in colour as possible.

Since, writes Mr. Herbert S. Walker in the *Philippine Journal of Science*, the quick and thorough drying of copra has been shown to be of such vital importance in order to ensure the production of a pure (*i.e.*, a good keeping) oil, an investigation of the various methods of copra drying has been made, not only those common in the Philippine Islands, but also those used in other countries.

The simplest and most primitive mode of drying copra is to expose the nuts, cut in halves, to the action of the sun during about five days. A drawback to this method is its

exceeding slowness, thereby not only causing the planter loss of time and money, but as with cacao, should a sudden rainstorm come on, or a succession of rainy days be encountered, mould and bacterial growth may appear, and the copra be spoilt. Even under favourable circumstances it seems doubtful whether the copra ever becomes sufficiently dried to turn out satisfactorily at the consumer's factory.

Copra dried by laying the half-nuts, face downwards, on a bamboo grating over a slow fire of coco-nut husks, known as the tapáhan process, although cheap and comparatively rapid, has the disadvantage of yielding a dark-coloured product which has a smoke-like taste and odour. Such copra also tends to have too much moisture left in it, on the average more probably than that which has been dried in the sun.

Drying by means of a hot-air chamber, as is or was extensively used for drying copra in Ceylon, is said to give a pure light-coloured product. The chamber used is apparently the well-known fruit-dryer, with wire-shelves one above the other. But here, the same as with cacao, it was found that the lower shelves, to insure an even drying, had to be constantly exchanged with those at the top, a method that loses heat, and is trying, cumbersome, and dangerous to those handling them. The less completely dried copra in the upper trays also is inclined to become slightly soured. "For

practical use," sums up Mr. Walker, "a dryer should therefore be equipped with some sort of a mechanical carrier, which would constantly introduce fresh coco-nut meat at the coolest part of the machine, and then bring it slowly down towards the hottest portion." Compared with the other processes mentioned, the time in which a rotary dryer can be made to extract the moisture is ridiculously small, viz. :—

Method		Time
Sun	...	5 days.
Grill (over bamboos)	...	10 to 12 hours.
Hot-air chamber ...	...	3½ " 4 "
Rotary hot-air process	...	2 " 3 "

The quantity of the copra produced by the hot-air chamber or shelf system is said to give a superior meat, being perfectly white, dry, of pleasant smell and taste. For oil-making purposes, however, Mr. Walker claims that the rotary apparatus, since it lends itself to a continuous process and requires considerably less time, is to be specially recommended, although its product does not present quite so pleasing an appearance. This, of course, referred to the crude apparatus made locally and used in the Philippines, compared to which modern invention and mechanical dryers, as shown here, should turn out the copra quickly and satisfactorily in every way.

It must, of course, be the aim of each individual planter to construct his drying houses

in the most rational manner at the least cost to himself, so long as the utility and efficaciousness of the building are not unduly sacrificed in one's anxiety to save money. It is meant by this that the planter should endeavour to use those suitable materials which are most readily to his hand in his own locality, such as native timber and boards, limestone, or brick, &c., so long as they will serve the purpose.

Wherever it is at all feasible, however, the roof, or at least that part of it which lies directly over the hurdles, should be made of corrugated galvanized iron sheets to render it absolutely impervious to showers, however heavy they may be, and, for a scarcely less important reason, for cleanliness.

This central roof should be wide and high enough for sufficient cover, and for as free evaporation inside as possible. The side roofs over the cooling floors of the building may safely be constructed of "attap" (the leaves shorn from the fronds of the palm, and bent double closely side by side over a stick about 4 ft. long). An attap roof can be made perfectly watertight if properly and narrowly laid, and it will, in such cases, last three to four years without renewal. There is, of course, with such roofs, always the danger of fire by sparks from the furnace, but such risks can be lessened if battens of bamboo are fastened across the top at intervals of about a foot or so, to prevent the ends of the leaves becoming loose in a wind,

and so apt to catch the sparks. The ability to have these comparatively extensive side roofs constructed from attap is, in many localities, an important consideration from a money point of view, as in some out of the way regions the cost of galvanized iron is very high, almost prohibitive in fact.

As for boards and scantling, there are few places indeed nowadays in the East where it is not possible to obtain them cheaply on the spot, even of native make. Lime for mortar, from coral and shells washed up, is almost everywhere to be had for low figures, or may be made from Nature's supplies spread broadcast in or over the soil in all the regions where it is profitable to plant coco-nuts.

The copra so treated has on completion of the drying process a fine and even whitish appearance, not yellow or smoke-affected; and the oil, on expression, has a sweet, pleasant odour, not rancid and pungent like the trade-copra of the South Seas or that from Zanzibar, Madagascar, Commoroh, &c.

It is obvious that in breaking the nuts care should be taken to obtain mostly large, and not small, pieces, which take more time and cost more money to handle. This is gained by strict supervision of the native workmen, who should only use sharp, clean tools. More injury than is generally credited is caused by discoloration through the use of iron rods with flattened ends rammed into the ground, or of

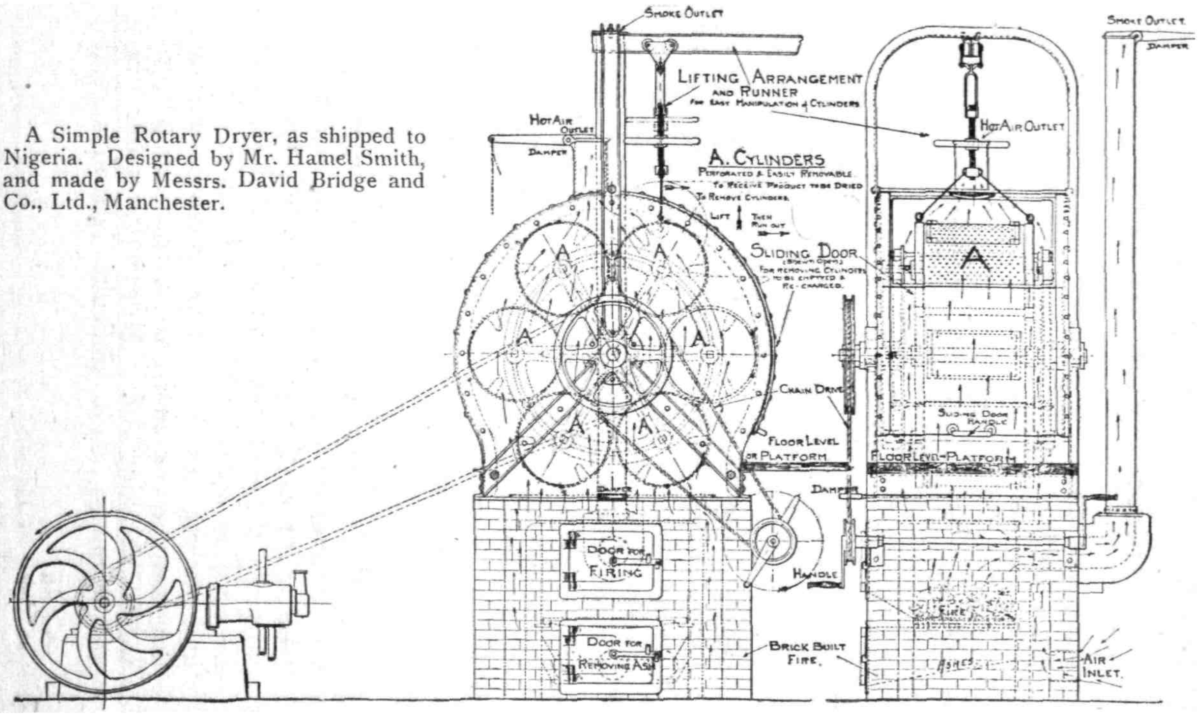
hatchets, for the husk-breaking process owing to the milky kernels coming into contact with the metal. There are in the Tropics many fine-grained hard-woods eminently suited to this purpose, which are, therefore, almost universally used by the natives themselves.

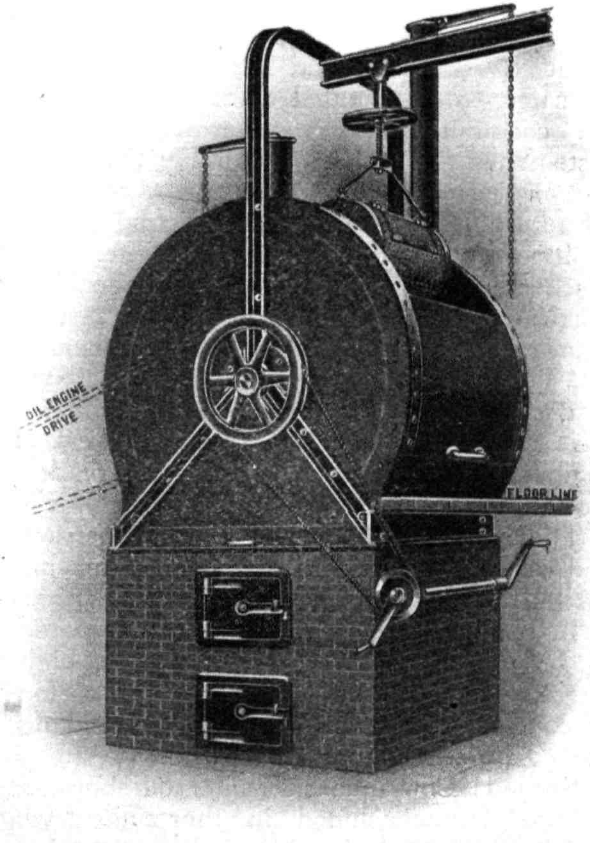
Grit and sand should be carefully eschewed in the immediate surroundings of a copra-drying establishment, especially in the earlier stages when the kernel is still wet from the milk. It should never be attempted to separate the kernel from the shell until the former is perfectly surface-dry, when it can easily be removed with a hard-wood club, preferably square at the hitting end to enable the operator to deliver slanting blows.

A few more remarks regarding the mode of drying.

We do not believe that in the present system of drying on hurdles we have the last word and the most perfect method. For it stands to reason that with the hurdles placed one above the other only the lower tiers will get the full heat, whilst the top layers get hardly any, or only when heavily saturated with water, as the original heat, on mounting upwards through the wet and cold tiers, is necessarily considerably cooled as it rises; and at the top will have retained hardly any heating or moisture extracting powers worth speaking of. Moreover, under the circumstances, it is difficult, laborious, and

A Simple Rotary Dryer, as shipped to Nigeria. Designed by Mr. Hamel Smith, and made by Messrs. David Bridge and Co., Ltd., Manchester.





THE "HAMEL SMITH" DRYER (exterior).
Made by Messrs. David Bridge and Co., Ltd., Manchester.

dangerous, on account of the heat, to open the doors and change the hurdles about.

It has, therefore, occurred to us to apply a rotary scheme of drying, such as we are about to describe, and which we feel can be safely recommended to the attention of the coco-nut planting fraternity. Such a system has the further advantage that it can be constructed for small or large capacities, all according to the means or actual requirements of the individual planter or estate. Such a scheme is, of course, hardly applicable or worth while to an estate or area of, say, less than 50,000 trees, but even here co-operation will do a great deal with a view of saving cost, and it would be the easiest thing in the world for several small holders to co-operate in the purchase of a rotary drier, for mutual use and benefit.

The main advantages of a well-constructed and carefully-designed rotary drying machine, as illustrated on pp. 386-7 and 390-1, are:—

In the first place, by keeping the material to be dried constantly in motion, a higher degree of heat may be safely applied, so long, of course, as it is not sufficient to endanger the copra by scorching or withering.

Second: Consequent considerable shortening of the time consumed in thorough drying, which can be calculated at one half at least, thus bringing the hurdle-process of twenty-four hours down to about ten to twelve.

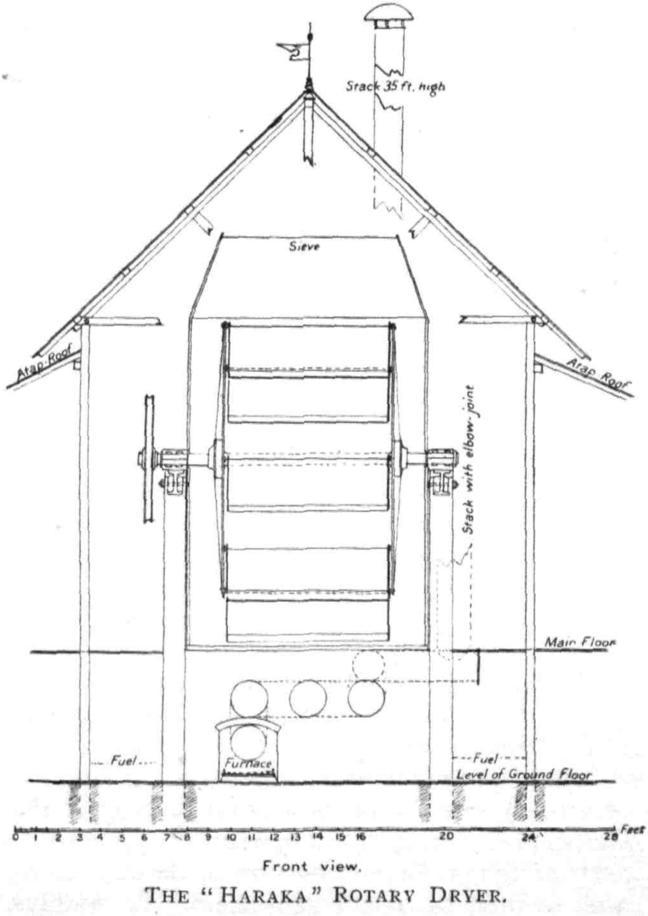
Third: The process of loading the revolving wheel by means of the trap-doors at any corner preferred, as shown in the illustrations, does not appear to occupy more time than it takes to shift or change the hurdles through the various doors on to the trestle-racks, as we have just described.

Fourth: The even distribution and application of the heat, aided by the gentle draught caused by the motion of the wheel, will produce the highest possible excellence of the copra.

Fifth: The material does not have to be handled from the time it is put into the machine until it is taken out to be spread on the main floors for final cooling and drying in the outside atmosphere, thus saving any chance of possible contamination by dirt and grit, &c.

Sixth: Bulk for bulk, in comparison with the space required, it is possible to dry a much larger quantity of material by means of the wheel than by the stationary hurdle process, because a larger number of hurdles or trays of rather bigger dimensions can also be submitted to the direct influence of the heat at a time.

Until quite recently it was a matter of secondary importance how long it took to dry the copra, the great majority of plantations and holdings being of inconsiderable area, and owned by small producers. Nowadays, however, speed and efficiency in drying are of prime importance, and need care and attention.

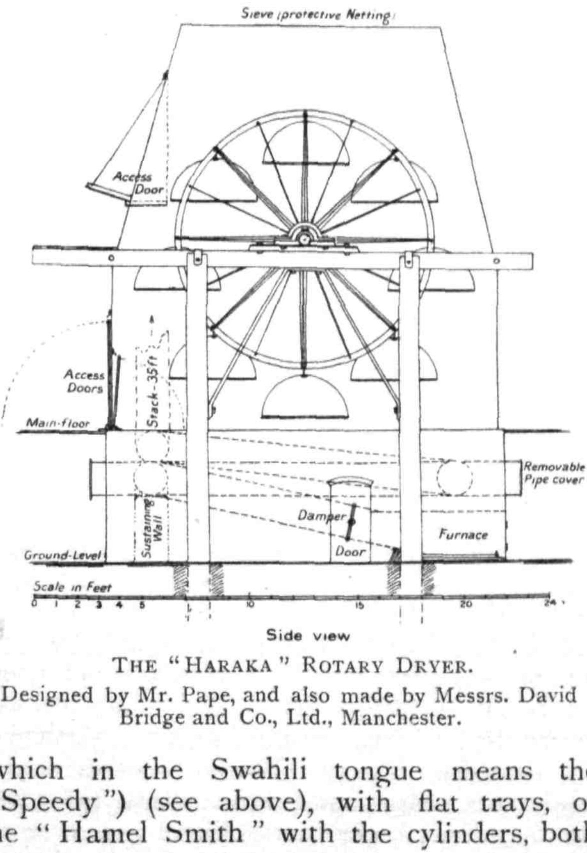


Front view.

THE "HARAKA" ROTARY DRYER.

Designed by Mr. Pape, and also made by Messrs. David Bridge and Co., Ltd., Manchester.

After much study and consideration we have evolved two workmanlike and inexpensive types of rotary dryers known as the "Haraka"



THE "HARAKA" ROTARY DRYER.
Designed by Mr. Pape, and also made by Messrs. David Bridge and Co., Ltd., Manchester.

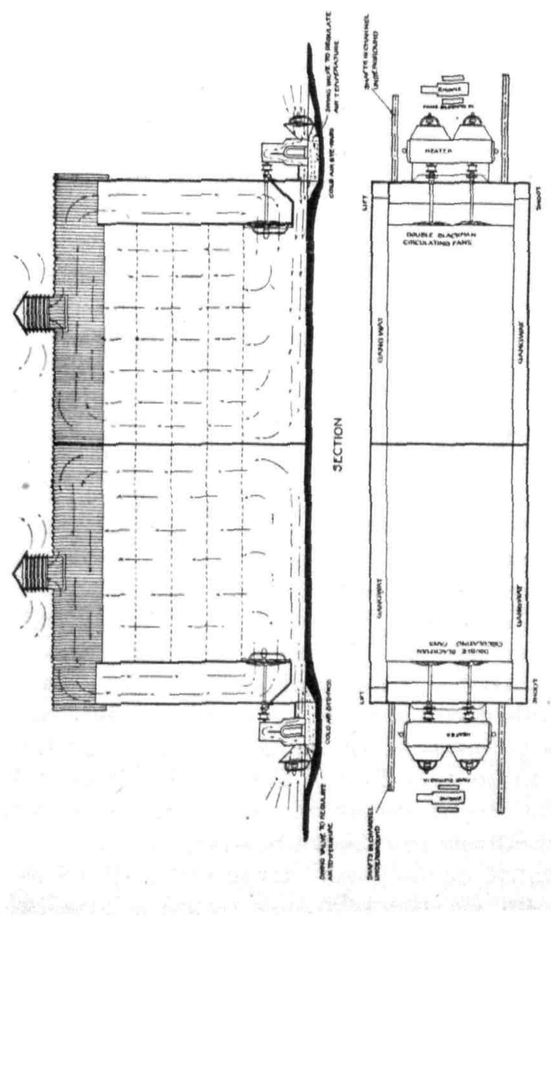
(which in the Swahili tongue means the "Speedy") (see above), with flat trays, or the "Hamel Smith" with the cylinders, both

of which offer the advantages enumerated above. With the Hamel Smith dryer, in order to economize every inch of space available within the drum, the largest dryers are, as shown in the design on p. 386, now made with six large cylinders instead of the twelve smaller ones shown in the original patterns. It will be noted that each cylinder contains three sloping ledges or narrow shelves, which check the fall of the contents, and by dropping them gently towards the next ledge allow the moisture to escape and the air to circulate freely between the portions without harm to the produce (copra, cacao, ground-nuts, rubber-seed, kernels, &c.) inside in the cylinders. The cylinders, thanks to the lifting arrangements and runners introduced, can now be made up to any capacity, but we do not recommend a greater diameter than 2 ft. 6 in., or at the most 3 ft., for though the drum containing the cylinder revolves very slowly (only just fast enough to avoid scorching), a larger circumference would give too long a drop, and would also cause too heavy a bulk to fall over those below, thereby tending to crush and damage them. On the other hand, they can be made any length, so that the six cylinders will hold 10,000 lb. of green copra, to turn out about half that quantity when dry. Those wishing to have particulars as to price, &c., for these or other drying apparatus, must state what space they wish to be allowed per 1,000 lb. of green copra or other produce to be dried.

The motive power with both the "Haraka" and "Hamel Smith" machines can be supplied by means of steam, gas, or oil engine, b bullock or other animals, electric or windmi power. The gear is so regulated that th drum cannot be turned fast enough to damag the contents. Now that the tendency is for large estates and joint working under companies, it becomes imperative to find and instal methods which will handle and produce copra in bulk and turn out large quantities (say 1,000 tons or more in a month) of the finest quality in the shortest possible time.

While it has truly been said that the recent development of the plantation rubber industry on so phenomenal a scale has been unprecedented in the annals of industrial or economical agriculture, yet the possibilities of the coco-nut planting industry seem likely to prove hardly less so, at least so far as increased output of plantation kinds is concerned, and of late all the signs certainly point that way. The well-advertised and much vaunted properties of the soya-bean do not and cannot come into direct competition with coco-nuts. Both are necessary, one cannot be used instead of the other; those therefore wishing to push ahead with their coco-nut lands need have no fear of competition from soya-beans.

To those needing very large installations we would suggest the following designs, and, so far as space permits, will do our best to explain their possibilities and advantages.



ELEVATION OF A LARGE TROPICAL DRYING HOUSE.

Showing arrangement of the Blackman fans and the heating appliances.

"Copra may be dried in the sun until all but about 10 per cent. of the moisture has been driven off, and sun-dried copra, if weather conditions are favourable," says Dean C. Worcester (p. 17 in his book), "is very white and brings a high price, but it is liable to get wet when drying and this darkens it; any person, therefore, producing copra on a large scale should instal an artificial drying plant. Copra dried on the lines of the Gloucester (Mass.) system for drying codfish, by the aid of a large rotary ventilating fan, would, or should, give a snow-white product, and cause higher prices to be realized."

It was in order to meet the growing demand for the necessary apparatus to dry copra, rubber, cacao, &c., on a large scale that we collaborated with our friends, and designed the buildings described in the following pages. In the building on p. 394 the four floors have been arranged to provide a total drying area of 11,000 sq. ft. or about a quarter of an acre in extent, and the Blackman Export Co., Ltd., claim that with their fans, 10 lb. of wet or green copra can be dried per square foot. This area (11,000 sq. ft.), therefore, should be easily able to take 80,000 lb. of wet copra per day (or 7 lb. per square foot), which, with a 40 per cent. evaporation, would give 48,000 lb. copra ready for shipment.

The building shown is provided with skeleton floors with strong woven wire, or

wire cloth, stretched tightly across, and securely fastened on all sides to the joists placed 2 or 3 ft. apart underneath. Over the wirework, which must be of small mesh, both for strength and to keep, as much as possible, small pieces of copra from falling through, it would probably be found best to lay loosely woven sacking, or native-made matting, to prevent rust from affecting the copra. Recent improvements in the alloys of metals used nowadays for making wire, render them, we are told, rust proof even in the Tropics; those, therefore, laying down wire flooring as described above might inquire from the makers as to which wire they should use. The matting, even with rust-proof flooring, might still be found useful to carry the copra, when dried, to the shoots (shown in the plan) by means of which it can be lowered to the ground floor, whilst fresh supplies are sent up by the lifts or hoisting apparatus on the other side of the building.

Having described the building we will explain how it can be used for drying copra on a large scale. The heaters shown, which can be specially constructed to burn coco-nut husks and shells, or other refuse, as fuel, are able to heat part of or all the air blown through the air-ways by the four propeller fans, two to each heater. A by-pass duct and a swing valve enable any desired proportion of normal air to be forced direct into the building with-

out going through the heater. This provision enables the temperature in the building to be kept under control. The air from the heaters and by-passes is forced up through the four floors to the roof spaces. The four large circulating fans draw most of the air from the roof space down again into the ground floor, whilst the rest escapes into the open air through the two louvred turrets in the roofs, one in each portion of the building.

By means of the circulating fans all the air is made to pass three or four times through the floors, thus ensuring its picking up all the moisture it can hold before leaving the building. All the fans are driven from shafts in underground channels, as shown on the diagram, and these shafts are driven in turn from two oil engines, which can be used to drive the lifts.

It will be noticed that the machinery is in two sets, one at each end of the building, which is divided into two, each half being supplied with its own stoves, fans, &c. The advantages of this are apparent, and include: (1) In case of a breakdown, or to repair the floor, &c., work is not altogether stopped; (2) filling and emptying the chambers can be carried on more quickly and with less waste of drying time than if the whole building had to be emptied or filled at once; (3) when the building has been filled and all is ready to start drying, the air can get warmed to the

required temperature more quickly; (4) whe crops are short, half the building can do bette work than the whole, and costs less to run (5) when the house wants aerating or sweeten ing, which is done by using the fans witl normal air, this can be done to one half of th building, whilst the other half is still bein utilized for drying. Again, since by adjustin the interior arrangements of the buildin other crops, such as rubber, cacao, &c., car be dried with equal success, one half can be used for one crop and the other half foi another, as two products can seldom, if ever, be dried together.

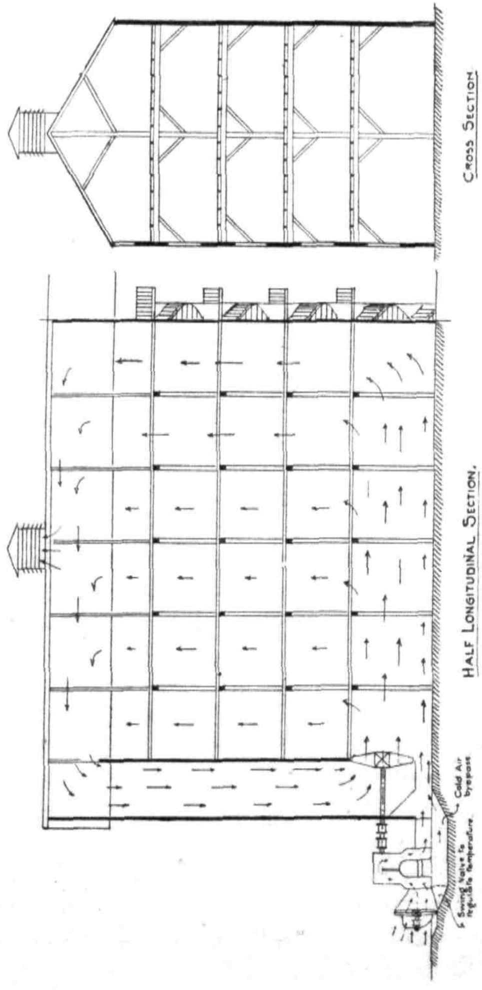
Those interested in rubber estates should note the following: "Whereas with the old form of hand-made sheets and biscuits two months was no unusual time for drying, this operation can now be much better carried out in a few days with the use of *crepe* machinery and *a simple method of hot air and fan drying*. The amount of costly accommodation that will be required by large estates to cope with increasing crops, if the drying is to take several weeks, makes it obvious that means must immediately be adopted to hasten this process (of drying rubber)."[1] This applies equally to copra.

On p. 400 is a plan showing the details

[1] Extract from the Annual Report of the Rubber Market for 1911, by Messrs. Gow, Wilson and Stanton, Ltd., London.

of the structure. For those crops where light is needed, windows can be provided, and in the original drawing they were introduced into the second half of the building, and can b seen by the light spaces up the wall on the left-hand elevation of the cross section. In making the block, however, want of space caused us to cut the building back to the spiral staircase as shown.

The building shown would stand about 40 to 50 ft. high by 100 ft. long. Many of our critics maintain this is far too high to safely withstand strong winds, and also on account of the cost it would run into, say, £500 for fans and heaters, £1,500 for the building itself complete, plus packing, freight across the water and transport to the estate on the other side, say, £500 to £1,000 more. The idea, however, can be equally well utilized with large shelves running on rails, that is, with the same floor area cut up into sections and provided with large iron rings to enable the men to run them out on to rails under cover of roofs extending on both sides of the building, when the dried copra could be let through a trap-door into a cart or receptacle below, to be taken away and cooled before being shipped (see p. 402). In the taller building the copra could also be raised and lowered through the floors, instead of outside, provided the owners did not mind the loss of floor space this would necessitate.



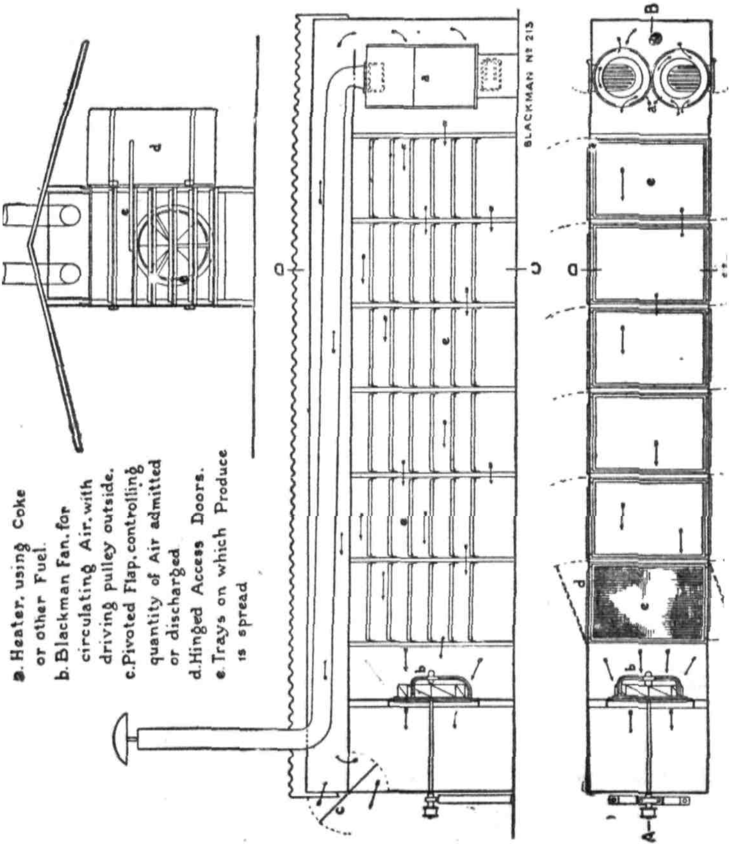
ELEVATION OF LARGE TROPICAL DRYING HOUSE.

Showing arrangement of floors and staircase and windows. (Designed by the Wire Wove Roofing Co., London.)

For anyone requiring a self-contained drying apparatus which provides the same favourable conditions obtained in drying out of doors when the weather allows, and who prefers a lower building provided with shelves instead of floors, the illustration on p. 402 may prove of use. It is constructed in various sizes, the one illustrated being calculated to dry about 2,000 lb. of cacao per day or the equivalent in other materials. The drying chamber is of galvanized sheet steel, and is (in this size) about 29 ft. long, 4 ft. 6 in. wide, and 8 ft. high. It is filled with perforated trays, made of galvanized wire, with a drying surface of about 439 sq. ft.

The warm air is circulated rapidly by a fan of large size, which draws the air first over the heated stove pipes, then through the heating chamber, and thence over and under the trays on which the material is spread. There is, of course, no contact of the air with the fires, or any possibility of the products of combustion entering the drying chamber.

The temperature of the air is under absolute control and regulated by means of the swing door "C," which also controls the quantities of fresh air admitted and moist air discharged. The greatest economy in working is assured, because the heated air is used to its fullest drying capacity. The swing door is so arranged that, by partly opening it, the moist air is allowed to escape below it while the corresponding quantity of fresh air which



PLAN OF DRYING HOUSE.

Showing arrangement of the shelves with Blackman fans and heating apparatus.

enters above cannot reach the drying chamber until it is heated; meanwhile, the main body of air continues rapidly circulating through and through the dryer (as indicated by the arrows on the illustration), thus carrying away the moisture rapidly, and evenly drying every part of the material.

The speed of the warm circulating air can be varied within very wide limits, as the fan is capable of moving more than 5,000 cubic feet of air per minute, and the direction of the air current can be reversed if desired.

The trays are interchangeable, so that the material may be moved from one part of the dryer to another, if ever desired, or taken elsewhere for the material to "cool off" after drying, to prevent sweating. Such a machine can easily be taken to pieces and packed for removal, and quickly put together by an intelligent person.

Any kind of fuel, such as coco-nut shell or refuse, wood, &c., may be used in these stoves, or the fan can be driven by hand or power.

The price complete would be about £300 or rather less, whilst a smaller machine with a drying surface of 240 ft. would cost under £150.

Another apparatus, known as the "Chula" copra dryer, is made by the Tyneside Foundry and Engineering Company, of Low Elswick, Newcastle-on-Tyne, who make a speciality of the drying of all kinds of tropical products. Their "Chula" drying machinery is working in many parts of the East, including India,

Ceylon, and the Federated Malay States, so can be said to have proved its claim for recognition as a useful drying plant.

There are two types of "Chula" dryers for copra, the first type being the continuous "Tunnel" Dryer, which is a self-contained machine and suitable for the drying of either large or small quantities. The second type of arrangement is that of fixed drying racks arranged in a subdivided drying room, the hot air being drawn from the "Chula" patent heater by a fan, and delivered beneath the racks by a system of light galvanized steel piping fitted with valves and outlets. This latter method of drying is suited for large quantities to be dried in bulk.

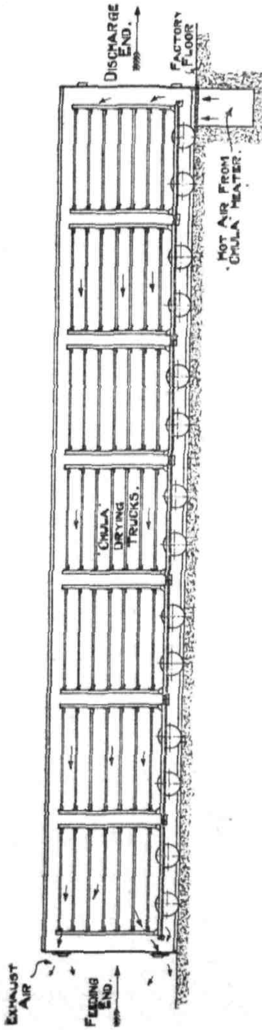
The principle of the "Chula" continuous "Tunnel" Dryer, as its name implies, is that of a tunnel through which the nuts are passed on trucks, moving against a current of hot air from the "Chula" heater. The whole arrangement is extremely simple, and one which can be readily worked and understood by estate coolies.

The tunnels are supplied either in single units or in groups of two or three, depending upon the amount of copra to be produced. The sides and top of the tunnels are made of sheet steel and are lagged with non-conducting material. They are shipped in flat sections of suitable size for transport and easy erection. Each end is closed by a swing door also covered with non-conducting material.

The tunnels are some 35 ft. in length, 4 ft. in width, and 5 ft. in height. The drying trucks upon which the nuts are to be spread are fitted with trays of expanded metal or strong wire netting. These trucks run on bearings and can be moved about with ease. The hot air from the "Chula" patent heater is forced by a fan into one end of the tunnel and is exhausted by regulated outlets at the other end. Being under pressure the air flows evenly along the tunnel and is in contact with the nuts on both sides of the trays, thus ensuring an even and positive rate of drying.

The "Chula" patent air heater has been developed in connection with tea drying and is a simple and highly efficient apparatus. Any kind of fuel can be used in the furnace, but the makers strongly recommend charcoal as being the cleanest and most economical fuel; as in tea drying the pure carbonic acid fumes from the burning charcoal are cooled to a normal temperature and passed through valves to mix with the hot air, of which a large volume is heated by passing through tubes placed over the furnace. Except for slight losses by radiation every available unit of heat in the fuel is utilized, thus giving the exceptional economy for which this heater is noted.

Coco-nut shells make first-rate charcoal and naturally this kind would be used for copra drying when possible. Where any difficulty is



SECTION THROUGH 'CHULA' DRYING TUNNEL

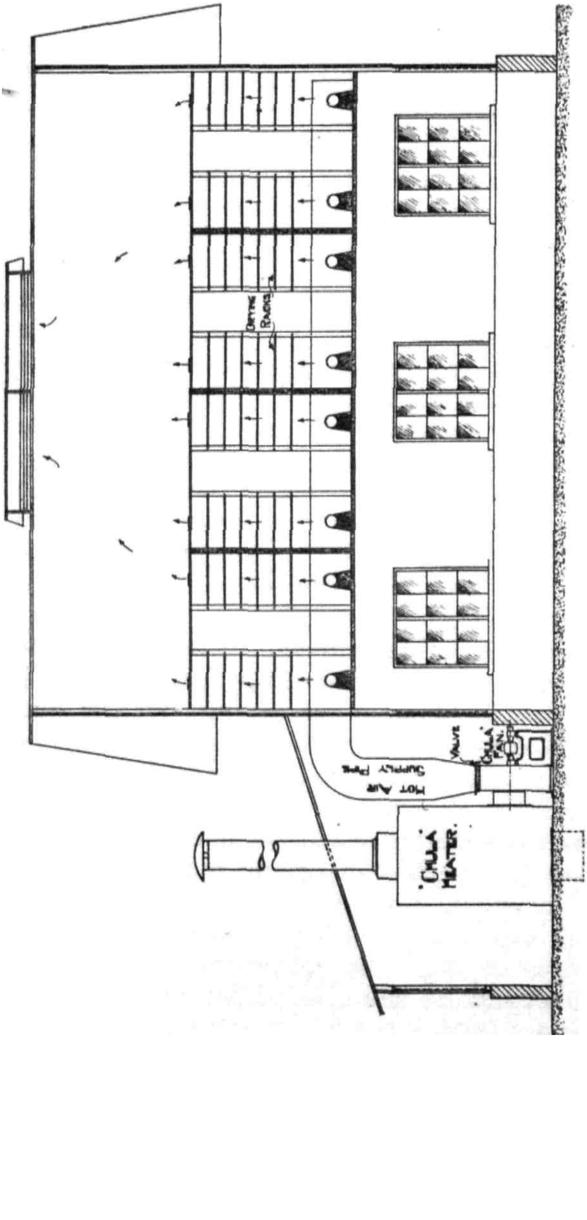
"CHULA" TUNNEL DRYER FOR COPRA (SIDE VIEW).
Tyneside Foundry and Engineering Co., Newcastle-on-Tyne.

experienced in converting the shell into charcoal by the crude native methods, the Tyneside Foundry Company supply a special retort for this purpose. This retort is simple and compact and produces charcoal with the minimum of waste. Used in the producer of a suction gas engine this charcoal provides by far the cheapest motive power for estate use.

For charging the nuts into the tunnel a truck is wheeled to some convenient part of the factory, where the nuts, split into two or three pieces each, are spread on the trays. Then as one truck of dried copra is drawn out of the *hot* end of the tunnel this truck is pushed into the *cool* end. This process goes on continually. The time taken by a truck in passing through the tunnel is about three hours. Opinions vary as to the best drying temperature to be used, but 150° F. seems to be the most generally accepted figure.

By erecting these tunnels in the loft of the factory, so as to be above the furnace, natural draught can be used for drying, but the outturn of copra is considerably reduced. The fan only takes 2½ h.p. to drive it, and the slight expenditure of power is more than compensated for by the superior results obtained.

For this method of drying it will be found most convenient to use the loft as a drying room, which takes us to the matter of the "Chula" drying room equipment. The drying room should be sub-divided by rough wooden



"CHULA" DRYING ROOM EQUIPMENT.
Tyneside Foundry and Engineering Co., Newcastle-on-Tyne.

partitions into several sections as shown on the drawing. A passage way, with a sliding door leading to each section, runs the length of the building. The sections themselves each have a central gangway on either side of which the drying racks are fixed. These racks are of wire netting and are about 3 ft. 6 in. wide and arranged in tiers about 9 in. apart.

The "Chula" heater is fixed outside under a lean-to, and the fan blows the hot air into a large pipe running the length of the building from which smaller pipes branch out underneath the drying racks. These branch pipes are provided with outlets controlled by sliding shutters to regulate the air discharge. Each branch pipe is also provided with a main valve by means of which the hot air can be cut off from any section, for charging and discharging, without interfering with any other section. The hot air passes upwards through the racks and escapes under pressure to the roof space, whence it is exhausted at the ridge ventilator.

THE COST OF MAKING COPRA.

In the May (1913) issue of *Tropical Life* the cost of making copra in Queensland was quoted as being £18 a ton. This statement caused the Editor to receive several calls, as well as a good many letters, from those interested in estimates for making copra, or from others who wished for further particulars for their own guidance. As a result of these communications we would say that if copra costs £15, £18 or any other sum c. and f., this amount can roughly be divided into three equal parts. One-third would be taken up in the cost of upkeep of large estates, for such areas as are in bearing, provided they were in good order to start with, and needed no exceptional expenditure, as heavy weeding or drainage, during the year; one-third (or on the basis of £15 a ton, it might, as shown later on, come to seven-fifteenths with interest) for interest, picking the nuts, and transporting them to the factory, for husking, splitting, removing the meat, drying the copra, and bags and bagging for shipment; whilst the last third (or maybe only three-fifteenths) goes for transport to the export ship and freight across. For copra to cost £18 a ton, the labour bill as in Queensland must be heavy, or else the cost may come in

for transport to the coast owing to the estate being in a district situated a long way from the sea-board. To our mind, for estates of 3,000 to 5,000 acres, or at least 2,000, and the entire area bearing, £15 per ton c. and f. should be, as a rule, a fair average cost for copra, for whether you pay a shilling a day for labour when making the copra, as to some Malays, or about fourpence a day, as with Kaffir or other cheap labour, as in Africa, the cost per ton works out much about the same, a good Malay being equal to three indifferent Africans.

If this is correct, and allowing 2,000 nuts per acre (trees 30 ft. apart), and 6,000 nuts per ton of copra, an estate would cost one-third of £5, or £1 13s. 4d., an acre for general upkeep. If the nuts were so large as to need only 4,000 to make a ton of copra (an estimate that we find too low, especially for large estates of 3,000 acres), then it would be extremely doubtful whether the copra would cost less to produce, as the nuts would only maintain their size owing to better cultivation and liberal manuring, which would run the cost up to 50s. an acre, and hence the same 100s. for the two acres necessary to produce 4,000 nuts.

When scientific cultivation by means of power tractors, ploughs and cultivators and manure spreaders, supersedes the present low-class labour engaged in "chipping" or hoeing the land, it will be interesting to see how the

cost per 100 or 1,000 acres compares with present rates. In Portuguese East Africa "chipping," we are told, costs 5d. per day's task (half an acre), or 10d. per acre. This is done three times a year, so costs 2s. 6d. an acre, plus the same amount for other expenditure, making 5s. an acre per year for work other than exceptional expenditure. Let us, therefore, work out the cost of a coco-nut estate of 3,000 acres based on the Portuguese Africa basis; and having done this, we hope others still on the spot, and especially those in Malaya, Mexico, Malabar, Ceylon, &c., will criticize our figures and compare them with their own. A coco-nut estate, all bearing, of 3,000 acres would need the following labour and expenditure in Portuguese Africa:—

	Per annum.
1 white manager's (or owner's) time ...	£800
2 under-managers at £250 and £200	450
20 drivers or overseers (equals one to 150 acres) at £5 a month or £60 a year	1,200
200 labourers (1 to 15 acres) with women and children. If there is not one woman and two or three children to each man then 250 labourers (or 1 to 12 acres) at 5s. an acre	750
1 white book-keeper	250
2 clerks (native) at £100 year ...	200
Total for upkeep, for labour only, exclusive of manure, machinery, implements, &c., equal to about £1 4s. 4d. an acre	£3,650

This area (3,000 acres) in bearing should give (at 2,000 nuts to the acre, and 6,000 nuts to the ton of copra) 1,000 tons of copra costing £3 13s. per ton (say 24s. 4d. × 3), as above for upkeep; add another £1 7s. per ton, or £1,350 a year, for renewals of supplies, &c., wear and tear, and sinking fund for labourers' buildings (if any), cultivating implements and estates' supplies, contingencies, &c., makes the cost of producing 6,000 nuts = 1 ton copra, exactly £5. In the estimate for making the copra must be included depreciation or sinking fund on buildings, machinery (if any), labour, bags and bagging, say 65s. ton, plus £3,750 interest on capital value of the estate (3,000 acres at £25 = £75,000) = £3 15s. a ton, whilst the remaining 60s. or £3 would go for transport, freight, &c., = £15 ton in all c. and f. Suppose the copra costs £12 only, or £18, then we still suggest that these same proportions for estate work, copra-making and interest, transport, and contingencies would stand *pro rata*. In the above we have not calculated anything for coir-fibre or other by-products, nor for catch-crops, either their upkeep or profit, but for cost of producing the coco-nuts and making and transporting copra only, and that from trees that are practically in *full* bearing.[1] Having thus made the start and shown our hand, it was up to others to explain where we were wrong, or confirm our statement where we

[1] See p. 418 as to why the yield fell so low.

were right. At the time we asked one and all to do this, and several replied, among them the following:—

The director of the largest plantation-coco-nut concern in Portuguese Africa, if not in the world, pointed out in his letter that the foregoing figures were much too low, and such an authority as an owner of estates and a large employer of labour is bound to take first rank for consideration. On June 14 last this authority wrote us from Marseilles: "Your figures are too low; according to our experience, you must reckon, for 3,000 acres, 300 men during six months for picking and transporting the nuts, 200 men for the same time for opening and drying, 200 men for the other work, as bagging, &c. In all, therefore, you need at least 700 men for six months. Besides this, you must further reckon 300 men for the general upkeep of the estate, tending the land, cattle, &c., draining, removing dead leaves, repairs to bridges, *extermination of pests*" (our friend heavily underlines these three words) "and the other work, as on a farm, and this labour force is required for the whole year." By this one must take it that at least 1,000 men are needed, or one man to three acres planted and bearing. Your labour bill alone, therefore, will come to much more than you have estimated."

Mr. L. C. Brown, Inspector of Coco-nut Plantations, was kind enough to send us the

following valuable notes: "Your letter to hand, but regarding the cost of coco-nuts per 1,000 to produce, your remarks appear to me rather vague, as it entirely depends upon what items of expenditure you intend to include. I may mention that in my opinion the only saving you can look for on an estate of 2,000 acres or more, compared with one of 500, lies in the cost per acre for supervision and buildings; for the general expense of felling, draining, maintenance, weeding, picking and the manufacture of copra would practically remain the same. An estate of 5,000 acres, however, might cause the planter to produce sufficient to feed a factory to turn out oil, coir and even to make rope, from which sources additional profits might certainly be looked for. An estate, say of 1,000 acres planted 30 × 30, or 48 to the acre, giving an average of 50 nuts per tree when in full bearing, should yield 48,000 × 50 = 2,400,000 nuts per annum, and I calculate on an average that 1,000 nuts will give 4 piculs 30 katties of copra, making the entire production amount to 10,320 piculs of copra in the year. Then again the average price of copra has been a good deal over $10 per picul (133⅓ lb.) cash price at Singapore or Penang for some time past (it is up to Rs.106 per candy of 560 lb. in Ceylon), but taking $10 as a reasonable average price ($ = 2/4) the gross revenue for the year would be $103,200 or $103.20 per acre. I now enter upon the cost

of production, which comes to $38.79 per acre, made up as follows :--

Quit rent	$2.00
Maintenance and transport ...	7.75
Picking, curing and maintenance at 1.50 per picul	16.51
Medical and contingencies... ...	3.00
Superintendence	8.00
Duty $1\frac{1}{2}$ per cent. ad val.	1.53
	$38.79 per acre

"The above allows for a European manager and assistant, also for a labour force of 180 to 200 coolies, that is to say five to six acres per coolie.

"The capital required to bring such an estate into full bearing, or let us say up to the eighth year, may be taken as $200,000, or $200 (£23 6s. 8d.) per acre, to which has to be added the cost of the buildings and factory, say $60,000, or $260,000 (£30,333) in all."

According to these figures, if our calculations are correct, we arrive at the following: Deduct $38.79, cost of production as above, from $103.20, the gross revenue per acre of forty-eight trees, and you obtain a net profit, annually, of $64.41 per acre, and therefore $64,410 (£7,500) on the thousand acres. As coco-nuts are considered to be a sound and lasting investment, this may surely be regarded as an excellent return, even after allowing for the setting aside of a certain amount for deteriora-

tion of buildings, for interest on the capital, and to provide for a reserve fund.

Again, at 2,400 nuts to the acre, and $4\frac{3}{10}$ piculs[1] to the 1,000 nuts, rather over 10 piculs can be calculated as going to the acre. Let us call it 10 piculs to facilitate calculations. On such a basis as we have been discussing, the copra would cost $3.87 per picul to produce, against $10.32 gross revenue per picul per annum. At 50 nuts to the tree, four palms would therefore give 200 nuts or about 1 picul of copra, or an average net profit per year of $6.45 (about 15s.), equal to 3s. 9d. per palm, exclusive of interest, reserve fund, or deterioration.

As Ceylon has been quoting up to Rs.106 per candy of 560 lb., after a stiff rise had occurred, $10 or 23s. 4d. a picul of $133\frac{1}{3}$ lb. is near enough for a trustworthy estimate.

"The cost of copra making in Samoa," wrote Mr. H. J. Moors from Apia, as recently as August 13, 1913, "varies on different plantations owing to many causes. One estate may be quite level and well roaded, another hilly and cut up with gullies. One near the sea, and others well inland over a poor road. One employing Chinese, and another Solomon Island labour, and a third using Samoans. All of these causes make great differences in

[1] Picul = $133\frac{1}{3}$ lb.; 100 katties = 1 picul; 16 piculs 80 katties = 1 ton; 3 piculs = 400 lb.; $ = 2s. 4d.

the cost of gathering the nuts and in turning them into merchantable copra delivered at the seashore or shipping port.

However, I do not think that even the most expensively worked property will have a charge of more than 70 shillings per ton of 2,240 lbs. for this item. As cattle are always in demand, and as, by wide spacing the trees, say planting 27 × 27, or 30 × 30, good grass in many varieties will flourish, the profit from the sale of the surplus cattle will go a long way towards offsetting the cost of making up the copra. Hardly any weeding under matured coco-nuts is done in Samoa, where cattle are raised on the properties; whilst, as regards the yield of copra per acre, fine estates give 10 cwt. per annum, others from 7 cwt. upwards, per acre.

Regarding the actual yields obtained from coco-nut palms,[1] we see that during 1912 the Kirivaula Coco-nut Plantation obtained 241,206 nuts from 7,591 trees, or an average of 32 nuts per tree, as compared with 44 nuts in 1911. This falling off, instead of an increase, was entirely due to the extreme drought that had been experienced, and had it not been for the manuring operations of the two previous years, Kirivaula would have done even worse. It is interesting further to note that out of the 241,206 nuts obtained, 31,666 made 22 candies (candy = 560 lb., or 5 cwt.) and 150 lb. copra,

[1] Published in *Tropical Life*, May, 1913.

which realized an average net price of Rs. 85.14 per candy; 107,870 nuts were sold at a net average price of Rs. 55.14 cents (Rs. 1s. 4d., 100 cents to the rupee); 5,000 nuts were planted; 6,670 were rejections (about 2½ per cent.).

This accounts for only 161,206 nuts, so possibly some of the figures are incorrect; for instance, if 197,870 nuts had been sold, and not 107,870 as stated, that would make up the 241,206 nuts plucked. The details given show, however, how a crop is divided up. The management of this company further report that during 1912 the bearing and blossoming palms on the portion of the estate south of the Deduruoya River were manured and good results are expected. It is proposed to deal with the trees on the north of the river in the current year. Buffaloes have also been used for manuring purposes by tying them to trees at night. Regarding the portion of the estate manured in 1912, the Visiting Agent, in his December Report, wrote: "The older palms are much finer now than they were a year ago, and their crowns have developed very much. There is no sign of any yellow about them, and given an adherence to the present programme of manure, I am sure these trees will yield heavy crops in the future." Supplying has again been rather disappointing, and white ants have done damage to the young plants put out, but by

putting in older plants, and with the use of kainit with supplies, it is hoped to get over this difficulty during the current year. Digging round palms continues to be done, and in general the condition of the estate is satisfactory.

The coco-nut crop of the Jambulade Tea and Rubber Company (Ceylon) was also below the estimate on account of the unfavourable weather.

As to the cost of bringing a company-owned estate, if well managed, up to the producing stage, we noticed that the Hon. W. H. Figg, speaking as chairman of the Coco-nut Estates of Perak, of which company Mr. Kelway Bamber is also a director, said that those present "would understand that to give details of the working of a place at such a distance and practically in a new district, was somewhat difficult. Means of communication were not easy, and the management of coolies in a new district was a matter of trouble. The opening up of the Bagan-Datoh district was a pioneering enterprise, and taking all the facts into consideration he thought the shareholders might be satisfied with what had been done. Personally he believed that, having accomplished the draining and the satisfactory planting of the 4,500 acres they, had a very sound investment at quite a reasonable cost. Some shareholders had asked what would be the ultimate cost per acre. In the prospectus they

anticipated that it would be possible to bring it to the producing stage for £20 an acre. In consequence, however, of the competition for labour, &c., it might come to one or two pounds more. In any case it seemed to him that it would be possible for a matter of £25 per acre, inclusive of the purchase of the land, to complete the work they had in hand. To have successful clearings at £25 per acre in a good situation, and with such a soil as they had in the Bagan-Datoh district was, it seemed to him, as good an investment as anyone could wish to have."

We include all these details because it confirms our estimate on p. 413 of £25 an acre, the interest on which having to be included, such an estimate must be arrived at before the planter can place any reliance on the cost of his copra.

EXPENDITURE AND REVENUE IN TRINIDAD, B.W.I.

FROM the foregoing estimates it will be seen that the Portuguese African estimates and those of Mr. Brown differ considerably as regards the cost of up-keep and making the copra; so it may be as well to add the following, taken from the *Bulletin* of the Department of Agriculture, Trinidad, W.I., for July-December, 1912, pp. 173 *et seq.* It runs into several pages, but we give only the details for opening up and bringing 550 acres into bearing during the first six years:—

Expenditure.

1st Year.

Cost of land (550 acres at 50s. per acre) ...	£1,375
Clearing 130 acres at 30s.	195
Roads and traces	50
Lining, holing, planting and seed-nuts (100 acres)	165
Weeding and cutlassing	150
Draining £25, ward rates and taxes £32 ...	57
Stock (5 oxen, 2 cows, 2 horses, 1 cart, stable, pen)	300
Labourers' barracks (12 rooms)	300
Dwelling-house	400
Supplies and contingencies	100
Superintendence	200
Total	£3,292

2nd Year.

Cultivating 100 acres planted first year	£175
Maintenance of roads, traces, &c.	25
Clearing 100 acres new land	150
Roads and traces, new	50
Lining, holing and planting 100 acres new land ...	165
Weeding and cutlassing, new land...	150
Labourers' barracks for immigrants (6 rooms) ...	175
Immigration charges on 12 immigrants	25
Ward rates and taxes	34
Supplies and contingencies	100
Superintendence	200
Total ...	£1,249

3rd Year.

Cultivating 200 acres already planted	£350
Maintenance of roads and traces	50
Clearance, planting, and cultivating 100 acres new land	515
Labourers' barracks for immigrants (6 rooms) ...	175
Immigration charges on 24 immigrants	50
Ward rates and taxes	35
Supplies and contingencies	100
Superintendence	200
Total ...	£1,475

4th Year.

Cultivating 300 acres already planted	£525
Maintenance of roads, traces, &c.	75
Clearing, planting, draining, &c., 100 acres ...	515
Labourers' barrack for immigrants (6 rooms) ...	175
Hospital for immigrants	300
Immigration charges on 36 immigrants	75
Stock (1 horse)	20
Ward rates and taxes	36
Supplies and contingencies	100
Superintendence (1 overseer added)	275
Total ...	£2,096

[By courtesy of Messrs. Stephens, Ltd., Trinidad, W.I.

A DOUBLE-HEADED COCO-NUT IN THE WEST INDIES.

5th Year.

Cultivating 400 acres already planted	£700
Maintenance, road traces, &c.	100
Clearing, planting, draining, &c., 100 acres ...	515
Labourers' barracks, for immigrants (6 rooms) ...	175
Immigration charges on 48 immigrants	100
Ward rates and taxes	38
Supplies and contingencies	100
Superintendence	275
Total ...	£2,003

6th Year.

Cultivating 500 acres already planted	£875
Maintenance of roads, traces, &c.	125
Clearing 20 acres land for pasture, &c.	30
Labourers' barrack for immigrants (6 rooms) ...	175
Immigration charges on 60 immigrants	125
Ward rates and taxes	40
Supplies and contingencies	100
Superintendence	275
Total ...	£1,745

12th Year.

General expenditure	£1,540
Reaping, &c., 625,000 nuts...	250
Making and delivery to shipping port, 43,125 lb. copra[1]	20
Copra drying house...	250
Oxen and cart	100
Total ...	...£2,160

[1] This seems to be based on an estimate of £5 per 10,000 lb. copra, for we are told that in the 9th year, making and delivering 4,140 lbs. copra, £2; 10th year, making and delivering 10,350 lb. copra £10. It will be noticed by the revenue that only a portion of the nuts are made into copra, the balance, *i.e.*, the selected nuts, are shipped whole.—H. H. S.

13th Year.

Reaping, &c., 1,075,000 nuts	£430
Making, &c., 74,175 lb. copra	34
Other expenses	2,040
Total	£2,504

14th Year.

Reaping, &c., 1,465,000 nuts	£586
Making, &c., 101,085 lb. copra	46
Other expenses	1,890
Total	£2,522

15th Year.

Reaping, &c., 1,825,000 nuts	£730
Making, &c., 126,525 lb. copra	58
Other expenses	1,740
Total ...	£2,528

16th Year.

Reaping, &c., 2,120,000 nuts	£848
Making, &c., 146,280 lb. copra	67
Other expenses	1,640
Total ...	£2,555

17th Year.

Reaping, &c., 2,250,000 nuts	£900
Making, &c., 155,250 lb. copra	71
General expenses	1,640
Total ...	£2,611

Revenue.

The nuts shipped are calculated at *$16* = *£3 6s. 8d.* per 1,000, whereas now (October, 1913) they are quoted at *$40* per 1,000 for selected nuts in bags of 100. We give only

the last three years, but the summary with which we conclude is based throughout on the same rates, viz., $16 for nuts and 4¼ cents per lb. for copra.

15th Year.

By 1,460,000 nuts shipped, at $16	...	... £4,866
" 126,525 lb. copra, at 4¼ cts.	...	... 1,120
	Total ...	... £5,986

16th Year.

By 1,696,000 nuts ...	... ...	... £5,653
" 146,280 lb. copra	... ...	... 1,295
	Total ...	... £6,948

17th Year.

By 1,800,000 nuts ...	... ...	... £6,000
" 155,250 lb. copra	... ...	... 1,375
	Total ...	... £7,375

Expenditure is based on average Trinidad conditions as regards: (1) Labour supply; (2) soil conditions and shipping facilities. Readers should, of course, study the *Bulletin* itself, if still available, for we have left out much valuable material and details. We will, however, include the following summary:—

Year	Expenditure	Revenue
1st	£3,292	—
2nd	1,249	—
3rd	1,475	—
4th	2,096	—
5th	2,003	—
6th	1,745	—
7th	1,540	—

Year			Expenditure			Revenue
8th	...	...	£1,540	...	...	—
9th	...	...	1,566	...	...	£197
10th	...	...	1,605	...	...	497
11th	...	...	1,680	...	...	1,066
12th	...	...	2,160	...	...	2,048
13th	...	...	2,504	...	...	3,523
14th	...	...	2,522	...	...	4,801
15th	...	...	2,528	...	...	5,986
16th	...	...	2,555	...	...	6,948
17th	...	...	2,611	...	...	7,375
			£34,671			£32,441

At the end of the eighth year, as can be seen, the expenditure amounts to *£14,940*; from the ninth to the twelfth year there is a further expenditure (over revenue and therefore of capital) amounting to *£3,203* before the estate becomes self-supporting. Therefore the actual expenditure required, according to the above estimate, to bring an estate of 550 acres into bearing would be £18,143. (A Trinidad dollar = 4s. 2d.; 100 cents = $1; $*480* = £100.)

Our readers can judge from the illustration of the double-headed coco-nut tree, shown on p. 424, how freely the palms bear in the West Indies. We first noticed this wonderful palm in the second edition of the "Guide to the West Indies," by Mr. Algernon E. Aspinall, editor of *The West Indian Committee Circular*, through whose assistance, with that of Messrs. Lade and Co., of London, we secured the loan of the block.

FIBRE, COPRA, ETC., IN BRITISH NORTH BORNEO AND THE NEW HEBRIDES.

WE noticed in a report of the fifty-eighth half-yearly meeting of the British North Borneo Company, that the Chairman, Sir West Ridgeway (who was formerly Governor of Ceylon, and has considerable experience of the possibilities of the Tropics generally for rubber, coco-nuts, &c.), told the shareholders the Company was ready to sell land to anyone who would take it, at an annual quit-rent of 1s. 2d. per acre. If this is so, then the possibilities of British North Borneo as a coco-nut centre should exceed even those of the Philippines, for if the latter can boast of a larger native labour supply, the Borneo Company (which enjoys sovereign rights over the territory and so is a Government, not a trading company) is more settled. Land is being planted up with rubber, &c., so rapidly that additional labour is needed ; the authorities, however, seem fully alive to the importance of an adequate labour supply, as they are carefully organizing the introduction of labour from China and elsewhere. In connection with this the Court of Directors, acting in

conjunction with the Borneo Planters' Association, recently sent a special commissioner, or representative, to China to establish a labour recruiting agency. Finally this was done, and the commissioner, Mr. Riddell, was placed in charge. Coolies are also obtainable from Java, where there is a large redundant population, for the Chairman, on his recent visit to that island, ascertained that the Government there would place no obstacles in the way of the immigration of coolies and settlers to North Borneo. It should be borne in mind that British North Borneo and the Federated Malay States are the only countries to which the Java Government make this concession. A certain quantity of local labour is available, and, we should imagine, supplies of Filipinos should be obtainable if Manila fibre was planted.

Taking the labour question therefore as settled, and an adequate supply assured, the low price of land in North Borneo and its great possibilities as a coco-nut producing centre must, we imagine, once capital is forthcoming, place it on a parity with the Philippine Islands, already one of the three chief exporting centres as regards coco-nut products. With its estates in skilled hands, and a clean slate to start with, Borneo—acre for acre—ought to do best, whether only coco-nuts are planted, or mixed estates, say, coco-nuts inland from the shore, then a belt of catch crops, and a stretch of

tobacco, rice, Manila fibre, &c., finally coming inland to where Pará rubber will thrive, and planting that. Large areas have already been laid down in rubber, and seem doing well. Those, therefore, who, like ourselves, believe in mixed plantations, and coco-nuts laid down as the main crop on a large scale, at least 20,000 acres or 1,000,000 trees, will agree that North Borneo has a future before it, since its position is central in regard to consuming centres, and very suitable so far as soil, situation, and climatic conditions necessary for the crops mentioned are concerned. Published reports tend to show that coco-nuts, Manila fibre (*Musa textilis*), cattle and pigs, rice and sugar-cane, do well in the Philippines, so they should do equally well, perhaps better, if cultivated on a large scale in North Borneo. If Chinese labour is freely introduced, it would understand the management of pigs, and would soon learn how to prepare pig-products for market. They would also supply a good local market for the flesh, the Chinese being large consumers of pork.

On p. 83 (*et seq.*) we discuss the cost of planting-up land in the Philippines, and of stocking the estates with cattle. With one or two variations, to suit local differences, the same total cost should serve with North Borneo; what you lose or save in some items you will probably make up with the others.

We also comment generally in the Philippine

This is how Abacá or Manila hemp (*Musa textilis*) grows at Ramon, Mindanao. Photographs of the plant in British North Borneo show a more lusty growth even than the above.

section on planting Manila fibre with coco-nuts. At present the price of fibre is not very encouraging, but if the cost of production and extraction can be reduced they should still pay, at any rate, Manila hemp (*M. textilis*) should, and on a mixed coco-nut and fibre estate the minimum cost of production should be reached, through the utilization of the, at present, waste products of these various crops.

If, with larger estates, it may pay to establish a paper-making factory to treat coco-nut husks only, it certainly ought to pay to introduce machinery to treat the waste, if not the whole of the fibre, off sisal and Manila lands, in conjunction with any bamboos, sugar-cane megasse, and other waste raw material, always to be found on large estates, and produce paper, or paper pulp, from such raw material. If it is found profitable to erect a distillery to utilize the coco-nut milk, now entirely wasted, and make alcohol from it, so also could the same be done with manila waste, since, on p. 328, we show it can be done from sisal refuse.

The results published of the exhaustive investigations and experiments carried out in the Philippines in connection with the utilization of all these and of other waste products, should equally hold good with North Borneo, since the circumstances seem similar in both centres. Many of these particulars are referred to in the adjoining pages, so our readers can form their own opinions on the subject;

but all will agree, we imagine, that the matter is worth consideration, and should be given a trial, especially as North Borneo offers such excellent opportunities for planting-up the main crop, on which all the others depend, viz., coco-nuts.

The demand for land for this purpose has already commenced, and the Government on the other side are doing all they can to encourage the establishment of coco-nut estates. To reduce the cost at the start and to provide dividends until the coco-nuts come into bearing, Robusta coffee, since it has done so well in Java and elsewhere, could be planted, provided the labour is there to look after the coffee as well as the coco-nuts, which need the largest number of hands when planting is being carried on. It may be, as already suggested, that at such times Filipinos might be introduced for short spells, going home afterwards when the planting-out is complete. Soya beans and ground-nuts would also do well, as they give quick returns and benefit the soil. In face, therefore, of the cheapness of land in British North Borneo, we believe it will do well, and deserve the attention of those wishing to establish coco-nut estates on a large scale.

We will conclude with the following letter and photograph from Santo, New Hebrides, under date of October 26, 1912:—

"Little has appeared hitherto in the columns of your valuable journal (*Tropical Life*) regard-

ing the New Hebrides as a sphere for tropical enterprise, and yet, situated between degrees 12 and 20 south, with magnificent soil, and an average rainfall varying, according to locality, from 60 in. to 160 in., these islands offer exceptional opportunities for development in tropical agriculture.

"So far they have been scarcely touched, the total white population not exceeding 1,000. Land can be obtained in large areas at a low figure and, on the whole, I think capitalists who may be contemplating investment in tropical production could not do better than direct some attention to this little-known group, while British colonists are badly needed to 'leaven the lump' of the mixed element which prevails.

"Up to the present, development has been confined chiefly to the planting of coco-nuts in comparatively small areas, but it has been demonstrated that cacao, coffee and cotton thrive exceptionally well.

"Conditions appear to be particularly suitable for coco-nut culture, and to illustrate this I forward a photograph of a tree taken when it was five years and two months old. Since that time (some nine or ten months ago) copra to the amount of 86 lb. has been made from this one tree, notwithstanding the fact that two bunches of immature nuts were broken off during a gale. No manure has been used, and I would like to know how this compares with production in other parts of the world under similar conditions. The tree I instance is certainly above

the average, but it is not exceptional; I may add that from present appearances the

How Coco-nut Palms bear in the New Hebrides.
A Promising 5-year-old Coco-nut Palm at Santo, N.H.

same tree will not yield more than 20 lb. of copra for the coming year.

"I am, yours truly,
"A. S. Thomas,
"*Hon. Secretary*,
"*New Hebrides British Association*.

SAMOA IN 1913.

THE following notes from the pen of Mr. H. J. Moors are, we feel, well worth including :—

The output of copra in Samoa has steadily risen from about 8,000 tons in 1901 to 11,000 tons in 1911, and the prospects are that within the next six years the present output will be at least doubled. As early as 1904 Ordinances were in force compelling all able-bodied natives to plant at least fifty nuts per annum, to be spaced 30 ft. apart and kept free of harmful weeds. As a result of this policy on the island of Savaii, where the regulation was more completely enforced than on Upolu, statistics show that fully 1,000,000 trees have been planted and cared for; whilst on Upolu, although possessing arable lands to offer in abundance, and with a population slightly larger than that on Savaii, it is very generally admitted that the supervision, being divided, and in many hands, has not been as effective, and the results have not proved as good. Owing to this probably not above 700,000 trees have, so far, been brought into existence on Upolu.

Of course, native owners controlled a large number of trees before the compulsory planting began at all, and it is chiefly from these that the present output of copra is gathered. Of

European concerns, the Deutsches Handel- und Pflanzung-Ges., of Hamburg, own and harvest crops from more than 7,000 acres of coco-nut lands, and as they so far obtain less than 3,000 tons per annum from their properties, it will be seen that the yield per acre is somewhat under half a ton; probably it does not, as a rule, exceed $8\frac{1}{2}$ cwt. per acre.[1]

The statement is constantly made by thoughtless planters all over the Pacific that coco-nuts commence bearing in their fifth or sixth year and continue to do so for a hundred years, reaching their maximum efficiency in their seventh or eighth year. While such conditions may exist in the Solomons, which are now being extensively planted, and where seemingly good authority backs up this claim, neither Samoa nor any other place known to the writer can show such results. Well-sprouted nuts set out in favourable situations in Samoa will show small fruits in the fifth year, but these will not develop, and even a small crop is not produced until the sixth year; whilst the tree must be at least eight years of age before it can be considered to have arrived at full maturity, and only then in the most favoured situations near the beach, exposed to the sea air, the salt water, or the underflow from the hills passing through its roots.

[1] This seems rather a heavy estimate, as half a ton of copra at three nuts to the pound = 3,360 nuts to the acre; at two and a half nuts to the pound of copra = 2,800 nuts to the acre.

In such favoured places coco-nuts may be planted rather closely, especially along the beaches, where the natives often grow then spaced less than 20 ft. apart; but it is good practice not to locate the plants less than 25 ft. distance, and many people favour 30 ft. × 30 ft. (forty-eight to the acre). On hill-sides where the trees rise tier on tier the rising rows may be closer, as the branches are not liable to interlock, and thus 30 ft. × 20 ft. may answer admirably; on the other hand, hillside nuts never bear full crops.

As a rule, about 5,000 nuts are required to make up one ton of copra, or about two nuts to 1 lb. of copra. On the Coral Islands, both north and south of Samoa, the trees never attain the same girth as they do in the volcanic islands.[1] They take much longer to come into bearing, and in the end produce a very much smaller nut. Expensive experiments have been made, and young coco-nuts have been treated with all sorts of manures in these out-of-the-way sandy islets, where it has been found that sulphate of iron, in small quantums, applied at long intervals, gives the best results. Apparently the natives themselves, in a blundering way, found out that iron in some form was needed, and for a long time they have deposited about the roots of their trees old tin cans, bits of chain, wire rigging, &c., &c., and have

[1] Subsoiling with explosives should benefit such land.

even occasionally driven spikes into the trees, asserting that such treatment was beneficial. Unless a fair amount of rain falls with good distribution throughout the year, coco-nuts will not grow and bear on sandy exposed islands of the sea, and many such places have lately been abandoned in the Pacific as unworthy of further outlays. This experience has been expensively bought and ought not to be lost.

In prospectuses, and even in such places as Samoa, the statement is frequently made that coco-nut trees bear annually about 100 nuts each. Manifestly this is incorrect, although at any time the investigator may see from fifty to 300 nuts ripening on the trees, for it is a fact that they hang much longer than is generally believed. In face of this it might pay to remove a large proportion of the nuts, and so give the tree a chance, and give the forty or fifty nuts—which is the most the planter can expect—every encouragement to become as "meaty" as possible, especially as many trees bear very little or even not at all. Some years ago the natives of Samoa were permitted to climb their trees and throw down the nuts for copra-making, and the result was that many immature nuts were made up into a half-dried copra and sold to keenly competing traders, by whom this mess was exported, but being of such low quality it brought poor prices and aroused the suspicion of every buyer in Sydney, where the bulk of the crop was marketed.

On proper representations being made to the authorities, natives were forbidden to throw down coco-nuts under any pretence, and they were further required to carefully sun-dry their output before offering it for sale. This Ordinance has for the most part been strictly obeyed, and to-day Samoan copra is, perhaps, the best that enters the Australian markets. This result, and the great extension of the coco-nut planting industry, may be ascribed largely to the efforts of ex-Governor Wilhelm Solf, and those who advised him in Samoa.

About one-fourth of the Samoan copra crop is kiln-dried, and of course this brings an especially high price owing to its cleanliness. It does not, however, contain a larger percentage of oil than the discoloured sun-dried copra does. Smoke drying is never practised in Samoa. Coco-nuts left on damp soil will sprout in a short time, and within four or six months they will throw up a shoot of from 8 in. to 16 in.; these nuts are then ready to be planted, and are almost invariably set out on their sides with the shoot standing erect. Nuts which have attained eighteen months or two years of age may, in wet weather, be transplanted, but the set-back which they get when most of their roots are cut off, holds them stationary for such a long period that it is likely that the younger nut will outstrip them, and in the end prove a better tree.

The weeding of coco-nuts is, of course, a

very expensive but a very necessary work in bringing forward a plantation, and while the nuts are young they have to be attended to in this way to bring them along, and enable them to care for themselves. No plant more quickly responds to good treatment than these palms do. At first, while the shoot is small, a circle extending 2 ft. around the nut is weeded, but within a year this has extended so that no grass is within 4 ft. of the nut; and as the tree advances the circle enlarges, until in the fourth year the tree is well out of the ground, and cattle may be introduced to weed and also to manure the plantation. In Samoa it is not safe to introduce them earlier, and often not even then, for on every property, however well regulated, there will be occasionally misses, that is, places where the young trees have died, and it is necessary in such cases to get new plants in and beyond danger before animals can be put on the land. Of late years a grass which was introduced by Mrs. R. L. Stevenson, and grown at Vailima, has pretty well overrun the whole country, and is to be found in the most distant places; this often takes charge of clearings. It is desperately fought against on cacao estates, but is frequently allowed to flourish on coco-nut properties. In shaded places it provides a fairly useful grazing ground, but cattle do not readily fatten on it, and where the sun gets at this grass it is coarse and many animals refuse it. Buffalo grass is no longer planted,

and is only to be found in isolated places. The best fodder is the native grass known as "Vaofalli," but this will not withstand the encroachments of the stronger Vailima, or the mimosa known as the "Sensitive Plant." This latter was formerly regarded as a scourge, but is now generally considered one of the best grazing grasses in the islands. Being covered with sharp spikes it has some disadvantages, making it difficult for the labourers to get about in it wherever it is allowed to grow rankly; but if the plantations are well stocked with animals the grass is kept down, and the labourers manage to get along all right. Couch grass is also an excellent fodder, but is not strong enough to fight against other grasses and weeds.

The natives, when clearing new land on which to plant the required number of coconuts, invariably plant taros, kava, and other supplies, all of which are of high value to them; and there is no reason in the world why the foreign planter should not set out taro, yams, bananas, pines, and other plants to help him through the lean years until the palms commence to bear or his cattle begin to return him an appreciable increase.

Taros and yams are saleable; kava occasionally produces satisfactory returns; bananas are useful and sometimes saleable; and pines, which might be grown by the million, could be canned and exported or crushed for their

delicious juice, and this bottled and sent away. An industry of this sort is just now starting in Samoa, and a good many acres are to be laid out in cacao and interplanted with catch-crops of pines, which are to be canned without sugar for export to Germany. On the other hand, the originators of this enterprise will certainly find that their cacao will not bear as early as it would have done had they left out the pines ; and it may not afterwards be as prolific, unless they make up with fertilizers the deficiencies in the supply of plant food caused by extensive pine-apple cropping.

The writer has so far noticed only one coco-nut disease which, though apparently widespread, is not disastrous in its effect. He is unable at present to say how it is caused or to suggest any cure for it. It only appears in young trees, *i.e.*, those less than three years old, and is mostly confined to those which are under two years. The leaves appear to suffer from lack of nourishment, and begin to wither up, commencing with the lowest branches. Sometimes the plant appears to recover, but this is seldom. If it is pulled out it will be found that the original nut which still adheres has rotted and emits a horrible odour.

When a planter sees such small trees about his place he is safe in removing them, and should disinfect the ground with lime, only setting in a healthy sprouted nut after the lapse of a reasonable period. This is the only

disease known to the writer which has so far appeared in Samoa, but not the only pest.

In 1909 the Rhino beetle made its first appearance close by the Customs wharf, where all goods have to be landed. It is supposed that eggs of this insect arrived here in some of the cases which contained rubber plants. Before attention was seriously called to this plague, it had already spread to westward about eight miles and eastward about two miles from the wharf. The alarm was given, and very drastic measures were proposed for calling in a large force of natives, declaring the copra industry and every man's welfare threatened, and asking the diligent collaboration of everyone concerned. However, other counsels prevailed and a great opportunity was lost.

The beetle meanwhile has spread over about one-half the extent of the fine Island of Upolu, to which it is still limited, and is costing the administration a heavy sum each year; and also, as all able-bodied natives in the infected districts are commanded to hunt beetles every Monday morning, they are suffering more or less further inconvenience as well. Soft wood and coco-nut logs are thrown together in squares of about 10 ft., and the centres then filled up with vegetable refuse so as to provide congenial breeding-places for the beetles, which patronize them with remarkable industry. Thus, the eggs and the larvæ are continually

gathered from the traps, and the supply of beetles in various localities is diminishing, but it is not supposed that they will be eliminated, although some thousands of such traps are now in use. The insects attack the palms in the usual method and in many instances they kill them outright, particularly very young and very old trees.[1] Besides this, they do much damage to other trees which may survive, but which cannot resist this scourge, although at the same time they yield full crops until they succumb. One planter sends men into his trees to remove the beetles with bent wires, or to drive them out with an injection of bluestone water made strong enough to fatally affect the insects. When these are removed the trees are painted with a mixture in equal parts of coal tar and kerosene. This produces a sort of thick varnish, and it is declared that no beetle ever attempts to bore through it. So far about 5,000 trees have been treated in this way, some being mere shoots less than one year old. None of them appear to have been harmed, and none of them have been revisited by the beetles, although they swarm on neighbouring properties. If bluestone injection is used to kill the mature beetle as he lies in the hole which he has made, care ought to be taken to use a mixture that is not strong enough to destroy the palm. Several

[1] For full particulars of this pest, the *Oryctes rhinoceros*, see pp. 270, *et seq.*, also (with illustration) pp. 124.

trees have, however, so far been killed in Samoa by over-powerful injections. As the branches grow the painting will have to be repeated, probably every four months, but it only takes fifteen minutes and costs 2½d. It has also been found here that cacao trees painted with the refuse of carbide of calcium whitewash are almost immune from the canker which, in a very bad form, is very prevalent in Samoa on neglected properties. Bud-rot has so far never shown itself in any of the islands of the Pacific. The Tonga group produce about the same quantity of copra per annum as is raised in Samoa, but owing to lack of regulation it is generally of a lower grade. Tahiti, the Marquesas, Potmutus, the Ellice, Phœnix and Gilbert groups in the South Pacific, and the Marshalls and Carolines in the North Pacific, also produce much copra; but the industry cannot be greatly extended in the Coral Islands, although there are no plagues or disease, because the available supply of land is almost all used up.

The cultivation of rubber and cacao attracts more attention in Samoa than does the cultivation of palms, but when the canker seemed to threaten the cacao industry many colonists at once interplanted coco-nuts on their cacao estates, and they are now coming to the time when they will have to choose which plant they will permanently retain. By the liberal use of potash manures it has been found that the coco-nuts and the cacao have, so far,

yielded maximum crops from the same land. Whether this can be depended upon to continue or not has yet to be demonstrated. The issue is an interesting one, and will be watched with much expectancy. Personally, the writer thinks that the cacao will decline in the long run and disappear, after the coco-nut palms have borne five or six full crops.

In conclusion, I would like to add that the general health of Samoa is excellent, probably better than that of London, Hamburg, or New York. The temperature seldom exceeds 82° F., so fevers are very uncommon. School facilities are remarkably good in all the lower grades, the Colonial Government schools being free to all.

About 1,300 Chinese coolies have been imported, and 600 new men are being sent for at the time of writing. These coolies mostly elect to sign on again in Samoa with new masters when their contracts are completed, thus testifying to their general contentment. It is expected that Javanese coolies may also be introduced in 1913. Suitable agricultural lands are worth, according to situation, from 10 dollars to 30 dollars per acre, and are not readily procurable. It is to be hoped that those in control will alter their views before long and allow the natives to lease for long terms of fifty or more years their surplus properties, which neither they nor their progeny can expect to put into service, for Samoa cannot advance much till then.

THE *NASICORNUS BEETLE* FUNGUS.

AN ENEMY OF THE COCO-NUT BEETLE.

MR. MOORS, who wrote us on September 20 (1913), reported in his letter that a parasite that fed on the larvæ of coco-nut beetles had been discovered in Samoa, to which it was indigenous. Whether the fungus can be successfully transported to other centres to wage war on beetle larvæ remains to be seen, but the matter is worthy of the closest attention, and we are much indebted to Mr. Moors for having called our attention to so valuable a discovery.

Many months ago, he tells us, Dr. Friederichs, Government Entomologist in Samoa, discovered that occasionally he would find a beetle larva with one or more small brown spots on its back. Observations showed that these larvæ were attacked by a natural fungus, native of Samoa, and that it fatally injured the insect. Experiments, therefore, are being carried out to further so desirable an end. Many beetle larvæ were captured and confined in boxes and old kerosene tins mixed up with plenty of rotting wood and cacao shells, and the effect of the fungus was watched

very carefully after it had been placed in the boxes. For months the result was very unsatisfactory, only few of the exposed larvæ being attacked. When Professor Doane, of the Leland Stanford University, was here, he also carried on a series of experiments with this fungus, and his best results also were far from satisfactory; probably, by continually feeding larvæ to this fungus, it has now become so voracious that when placed in a box containing the larvæ it will attack and eat almost every one of them. It has therefore been introduced into artificial breeding-nests made in the open for the mother beetles, and is destroying the larvæ as fast as they appear. Planters are now building nests, spaced about one to each acre, all over their coco-nut plantations, and beyond them on every side, and great relief is expected. The administration of Samoa is also putting in these nests in many places, spaced about 120 paces apart. Of course, it is necessary to clear up the adjacent country so that there will be no natural breeding-places for the beetles to discover.

The nests made in Samoa, and recommended by Dr. Friederichs, consist of a low frail stone walled-in space about 15 in. high and about 6 ft. across the top from side to side. The well-like opening is to be filled with rotting husks, old coco-nut wood, other rotting wood and, if possible, three or more bags of cacao husks fresh from the breaking. The whole is

covered with four or five inches of soft earth kept well weeded, and then a few handfuls of the fungus-infected earth is scattered over the top and covered from the hot sun several days until it penetrates to the refuse underneath. The smell of the fermenting cacao pods, or of the rotting wood, attracts the mother beetles, who come in great numbers to oviposit, and the fungus destroys the larvæ almost as fast as they come forth from the eggs. He concludes: "I have talked with the assistants of Dr. Friederichs, and with planters who are experimenting under his observation, and I have seen the dead and dying larvæ removed from the nests, and noted that the destruction is from 90 to 100 per cent. effective.

"It is likewise claimed that mother beetles who remain long in these nests are also affected, and leave only to find themselves suffering from the fungus cancer. I have seen here a trap about 30 in. × 60 in. in size, constructed of wood, wire netting and galvanized iron, and costing say 12s. to 15s. to make, which is said to have caught 460 beetles within three months' time. It is baited with live beetles, whose calls or odour attract their friends and relatives. Dr. Friederichs deserves great credit for his patience and scientific attainments, which must prove of the greatest use to planters."

The following appeared in the *Samoansche Zeitung* of September 13 (in German) in connection with this parasite :—

"The Plant Pathologist, Dr. Friederichs, has reported to the Imperial Governor as follows:

"'I have the honour to state to Your Excellency that, at the Vaitele Plantation, according to the opinion of the manager, Herr Eberhardt, complete success has been attained by the use of the *Nasicornus beetle* fungus. I must leave it undecided whether it will be a permanent success or not, but the present condition of the experiments appears, as a matter of fact, to be highly satisfactory.

"'Herr Eberhardt has, with exemplary energy and care, carried out, in a very brief space of time, the measures proposed to combat the beetle by means of the fungus.

"'In February last he received from the pathological laboratory 1 cwt. of fungus-infected earth, and at once formed a trap heap ("tumu") near the seashore of the plantation; then, after more of the material was infected, he set up two others on April 3, and five more on April 30.

"'Out of about 150 trap heaps, which had been previously placed in the same part of the plantation (these had been placed at distances from one another of perhaps 330 ft.), forty were thus, from time to time, caused to be infected, just in those parts of the plantation where the activity of the beetle had specially made its presence known.

"'As early as July last there were found in the same part of the plantation (in non-infected

trap heaps, and in other places) amongst the collected grubs about 30 per cent. of sick or dead ones killed by the fungus. That means, in reality, a larger percentage of destruction than the above, as the sickness acts rapidly and the dead bodies soon crumble to pieces and are carried away by the ants.

"'It is also worthy of note that this month, August, the men collecting beetles have found difficulty everywhere in that part of the plantation just mentioned, to obtain any full-grown larvæ. Not, indeed, that they had totally disappeared; but those found were all small—*i.e.*, a few days old. The older the larvæ are the more easily they are infected by the fungus.

"'At present the labourers specially collect the beetles in the vicinity of the plantation, and already find numerous sick larvæ there. On the west boundary, towards the village of Saina, more diseased grubs were found than along the east boundary, towards Vaiusu. This agrees with the prevailing east winds, which the beetle follows, spreading the spores.

"'Amongst 193 larvæ, collected for the most part beyond the Saina boundary, I found twenty-four sick ones. The disease is already beginning to gain a firm footing there.

"'The spreading of the disease in Vaitele took place in the dry season, certainly in a rather moist dry season; therefore what a much greater result we may expect in the rainy

months remains to be seen. The great moisture of the air prevailing in Samoa throughout the whole year favours very considerably the effect of the fungus. Undoubtedly excellent results have been obtained, and this success should incite us to set up infected trap heaps everywhere. To do this, however, the assistance of all the planters is needed, and some of them have already begun to render it.'

"Should we succeed in transplanting this fungus all over the country then we may hope that within two years the beetle pest will assume a very different aspect to that which it offers at present."

"As regards possible remedies to get rid of the rhino beetle, we have found that young coco-nuts, viz., those of one, two, and three years old, which are carefully and lightly tarred every four months, are protected from the rhino beetle; but as the trees advance in size, and grow faster, the operation to be effective has to be repeated very often, and would be too costly in labour to continue all the time. Nothing that we have so far tried has been very effective in destroying the beetles on the trees. We make breeding beds for them in beetle-infested places by digging up the soil and adding to it a lot of cacao pods buried about six inches beneath the loose dirt. The odour arising from the fermenting pods underneath seems highly attractive, and brings the mother beetles to these

places. Once every two months we throw out the dirt and decaying shells and gather in the eggs, beetles, and larvæ. The Government maintains breeding traps in various places which are examined every three months, and large catches are made. This method of attacking the beetle is expanding a lot, and will soon become very general. American Samoa is so far untouched by the beetle, but every Monday morning all of the able-bodied natives of German Samoa are sent out to hunt beetles, and they usually return with from fifty to 100 or more larvæ. Some of the districts, as yet unaffected, are of course excepted, but nevertheless the search is made for possible beetles.

A good breeding bed for beetles is made as follows:—

Take four coco-nuts logs each about 6 ft. long; lay them so as to form a square. Cut up a lot of partly rotten coco-nut or other wood which the beetles are fond of, all well rotted, of course. Then dump inside two, or more, hundred-weight of cacao pods just as they come from the breaking up; then cover the whole with soft earth, about 6 or 8 in. deep. Let the bed lie undisturbed for about eight or ten weeks; then throw outside the contents, and pick up the larvæ and eggs. After this, fill in your materials again, and then add a few more cacao shells if you can get them. Very large "tumus," as they are called here, are

frequently made in Samoa, but there is no reason why they should be so large—the writer believes in making many small ones, and at least one on every second acre. He has forty now on a section of 80 acres, and he is about to install forty additional tumus. They cost little time and labour to construct, as two coolies will make three or four a day, and they last for years. The beetle pest in German Samoa is certainly bad enough, but it would probably be a calamity were it not for the success of these breeding traps, and the weekly hunt established by the Government.

COCO-NUT PLANTING IN FIJI.[1]

THERE is a good deal of literature in circulation dealing with coco-nut cultivation in general, and in such places as Ceylon, India, and the West Indies in particular. But, as far as my knowledge goes, very little has been published as regards the same industry in Fiji. There appears to be a considerable difference in the cultivation of the coco-nut palm in the different countries. This may be due—to some extent at any rate—to different varieties being cultivated; but at present we are without any proper description or scientific classification of the many species of coco-nut palms which undoubtedly exist.

In establishing a plantation it should be borne in mind that the most suitable soil for coco-nuts is no doubt found on the alluvial flats or undulating land near the coast or on the banks of rivers near their lower course, where the effects of the tides are felt. As with all plants, good soil is preferable, but there is a great deal of contradiction and difference of opinion as to what constitutes good soil for

[1] By Mr. H. H. Thiele, Secretary to the Fiji Planters' Association. Reproduced from *The Fiji Planters' Journal*, Suva, Fiji, July and August, 1913.

coco-nuts. In the Madras district, the planters prefer red clay mixed with sand—free from lime and saline substances. At Gopnath (Bombay district) the palm grows freely in solid limestones, provided a hole about $3\frac{7}{8}$ ft. deep by 3 ft. diameter is cut in the rock and filled with mould.[1] In most places clayey ground is considered the least suitable. On the island of Taviuni the finest palms are nearly all grown on the slopes along the coast. The soil, which in many places has the appearance of being covered with stones, is of volcanic origin and very fertile. What look like stones are just disintegrated pieces of lava or scoria, and much lighter than ordinary rock. They have fertilizing qualities, and I have seen in several instances how sickly looking trees recovered in a short time by piling these rocks round the foot of their stem—say 4 ft. all round it and a couple of feet high.

Selection of seed-nuts is an important matter. These should be cut from healthy, heavily bearing trees (not under twenty years old) and not picked up from those fallen to the ground, which may have been cracked by striking some hard substance in their fall. Preference should be given to nearly round, medium-sized nuts with a thick husk. They should be dry and brown—not green—in fact such as would most likely have fallen to the ground if they had

[1] This must refer to rocky soil, not solid rock.—H. H. S.

been left on the tree a few days longer. In some places we are advised—by the sound of the water when shaking the nut—to sort out those which have too little or too much water in them, and reject them. This is hardly necessary or reliable, as defects of this description will most likely show themselves when the nut sprouts.

Beds are made in the fairly well shaded nursery by stirring up the soil to the depth of a foot or so, and in these the nuts are placed but not covered up. Two men bring in 200 nuts and place them in position in the nursery as a day's task. To gather the nuts one of them would climb the tree with a long rope, pass this over a couple of leaves, fasten it to the stalk of a bunch of nuts, cut the stalk close to the tree, and lower the bunch to the ground. The trees from which they were allowed to gather the nuts I had previously marked with a ring of black paint round the stem. In the nursery I placed the nuts in small squares 10 by 10 ft., in which position they were easily attended to, and watered them in their early stage every few days if no rain had fallen for some time. There was a constant stream of water running through the nursery.

Though it is sometimes difficult to see them, all nuts have three ridges on their outside skin, and some planters in Ceylon advise placing the seed-nuts with the top ridge in the ground for the first four weeks and then turning them over

Coconut tree with branches.
Curious phenomenon observed in the Cocos Islds.

on their opposite large flat side. I did this with some nuts, but could see no difference whatever in the development of those and the others, which had rested on their flat side all the time. It seems only reasonable to conclude that Nature in this respect is our best guide. When a nut falls from a tree it finally comes to rest on the ground on its flat side and from that position goes on developing.

When the seed-nuts germinated and the young shoots were about 18 in. long, I transplanted them to their final position in the field. According to a writer it takes twelve months for a growing nut to reach that size. In Taviuni it does not take so long, and nuts gathered in April and May were ready to be planted out in November, just before the rainy season.

On the subject of coco-nut planting, the Honourable Staniforth Smith writes as follows in the "Handbook of Papua" (1909)[1] :—

"The nursery is very easily and expeditiously prepared. Select good, loamy, friable soil, and trench it to a depth of 18 in., divided by paths 6 ft. apart, dig cross trenches 6 in. deep and 1 ft. apart, pack the nuts, unhusked, in these, 2 or 3 in. apart with the base or stalk end uppermost, which enables the shoot to come up vertically from one of the three eyes of the shell; return as much of the soil as will leave only 2 in. or 3 in. of the nut above the

[1] See also the section on "Papua," pp. 175, *et seq.*

surface. Water well and cover the beds with 3 or 4 in. of long cut grass. This can be found in abundance in the vicinity. In the absence of rain for a longer period than four or five days, the nuts should be watered from time to time. They should be ready for removal to the plantation in five or six months. The seed-nuts should be the product of healthy, heavily bearing trees. They should be ripe but not dry, heavy, and of an oval shape, with thin husks, the three longitudinal ridges of which should not be too prominent."

Before planting out, every vara (as sprouting coco-nuts are called in Fiji) was carefully examined. Those which had come on much quicker than the others, and those which were much slower than the rest, were all rejected. By this proceeding I lost perhaps 5 per cent. of the varas, but never as much as 10 per cent. It is not unlikely that excess or want of water in the nut may have been the cause of the too forward or too slow growth of the vara. At any rate, the condition of those 5 per cent. of varas was not normal, and for this reason they were condemned. The rest of the varas were a perfectly even-sized lot.

With holing and planting out, many different opinions have been given on the subject of the size of the hole in which the varas are finally to be planted, and the distance between them. I used to dig them 2 ft. square and 2 ft. deep with a distance of 28 ft. between

them, and this seemed to answer very well. Under certain special conditions, such as an abnormal condition of the soil or irregularity of its surface, other measures may be better. I have seen instances of several rows of trees having been planted much closer on one side of a coco-nut patch, so as to act as a break-wind for the rest, and I have heard of greater distances being allowed between the trees, so as to allow space for some other plants being cultivated between them. Deeper holes than those I have made are often recommended, but I do not think they are necessary in Fiji.

For transporting the varas to their ultimate place in the field, I used rather large shallow boxes with a handle at each end; these would hold about 60 varas as a load. In handling the plants the labourers were warned not to lay hold of the young leaves, which may thus be damaged and the growth of the vara checked. Unless the roots developed in the nursery are very long, there is no necessity for cutting them back. In placing the vara in its hole care should be taken that the roots are not bent or doubled up, they should take the same position as when growing in the nursery. The seed-nut itself should be placed so that the top of it is about 6 in. below the surface of the surrounding soil; this will in time, by rain and cultivation work, be washed in or pushed in, and thus fill the hole entirely. The reason for planting the varas a certain depth below

the surface varies according to different writers. One gives it as being done to protect the young plant against strong winds, but it is difficult to see the point in this; the lower part of the stem may benefit a little, the rest of the plant with its large broad leaves remaining unprotected. Another writer advocates filling up the holes flush with the surface at time of planting. A Ceylon planter was persuaded to do this. He lost 90 per cent. of his young nuts, and reckoned he had made a fool of himself. It is not unlikely that it is beneficial to the vara that the sun and rain get at the crown of the root at the start. By and by this becomes unnecessary, and by that time the hole has been more or less filled up, and the seed-nut covered by the effects of natural processes, as described above.

It is generally recommended to place some kind of manure in the holes in order to give the vara a good start, and thus make up for the check it received when being transplanted from the nursery. All I did some days before planting was to cut, dry and burn some of the grass growing near, and mix the ashes with the soil which was afterwards used in planting.

Now we come to the care of the young trees. When once the varas have got a good start, there is not much done to them here in Fiji. In other places they are watered for a considerable period, but this—as far as I know—has not been and is not done here.

During more than half the year at any rate it is certainly unnecessary; but we do now and again experience spells of dry weather—you can hardly call them "droughts"—which keep back the growth of everything. Watering on such occasions would no doubt be of great benefit, and probably cause the trees to start bearing much earlier. I would recommend that wherever possible salt (or sea) water should be used in preference to fresh water. The former is generally considered better for the trees and will help to keep down some of the weeds growing round the foot of the stem. In the West Indies the general opinion is that salt does not act as a manure, but when absorbed, it makes the stem of the palm stronger and more supple, so that it will withstand the force of the strong hurricanes experienced in that part of the world. If such is really the case, it would be of advantage to planters in Fiji to make experiments with salt or sea water—it would not cost much.

In former years, when the price of copra was only some £6 or £8 per ton, the expense of watering or manuring (even to a limited extent) was probably prohibitive, but at present, with the price well over £20 per ton, considerably more money might well be spent in getting the trees into earlier bearing and make them produce more and better nuts than was the case some years ago. It would pay well in the end to do so.

The question of manuring is a very important one, and the experience so far recorded seems to vary considerably. In my opinion there are two points which should not be lost sight of. The first is, that chemical manures should not be applied wholesale over an entire plantation, but only to those trees which do not bear a satisfactory number of nuts without it. The second point is, that only sufficient manure should be applied to such trees as will make them produce a satisfactory number of nuts without any unnatural exertion. There is a very great difference between manuring cereals and manuring trees. In the former case you manure the soil to obtain certain desired results within a comparatively short time, after which the plant dies. In the latter case you apply the manure to plants which may go on bearing for upwards of a hundred years. There is no doubt about it that you can increase the productive powers of the tree very considerably, but it is at the cost of curtailing the period during which they, under natural conditions, would continue to bear nuts. My opinion is that, when trees look healthy and bear satisfactorily in a natural way, they should be left alone and not encouraged to unnaturally large productiveness by artificial means. These latter may be applied to trees which actually require them in order to become productive at all.

I once experimented with a couple of young

fruit trees on these lines. They were quite healthy, I manured them heavily and thereby increased their yield to more than double the natural quantity. They went on for two seasons like this, and then died suddenly. I tried my best to save them as soon as I saw their condition, but did not succeed. There was no outward sign of any special disease on roots, stems or leaves; they simply lost all vitality, withered and died in a very short time. The same thing has happened to me when causing flowering plants by artificial means to bear an unnatural, excessive production of flowers. They soon died.

There is an opinion generally held that by analysing a soil intended to produce a certain plant, and knowing what that plant's chemical requirements or constituents are, you can tell exactly what manure should be used. This is, however, only true to a limited extent, and the reason in many cases is simply that, although a certain necessary ingredient is present in the soil in quite sufficient quantity, as shown by the analysis, it is not in such a condition as to admit of its assimilation by the plant.

My advice is that until you have ascertained for a fact what kind of manure your soil requires, when, and in what quantities it should be applied, you had better limit yourself to experiments only, and not waste a lot of money on guesswork.

What is written above applies to chemical

manures. Bonedust and dried blood have given very satisfactory results in other places. I would not recommend them here. I tried them in my vegetable garden, with the result that all the crabs and ants from the neighbourhood congregated there for a feast, and I got very few vegetables. The ants walked off with the bonedust, and I do not believe that I benefited by it at all.

As regards green manuring, I am in favour of it for any other kind of crop; but I have not tried it on coco-nuts. It presupposes to a certain extent the possibility of being ploughed in, or otherwise covered with soil, and this could not be done on the estate I managed. Cow-peas will probably answer best in Fiji; they grow up straight, may—if so wanted—be cut for cattle food, and the peas are liked by the Indian labourer and fowls. Beans—such as Mauritius, &c.—are likely to injure the young plants by climbing up their stems and lashing the tender leaves together. There is another leguminous plant growing profusely amongst the coco-nuts in most parts of Fiji—its local name is ka-moce (*Casia optucifolia*). It most likely does benefit the trees to some extent, but as a fodder plant it is useless and only takes up the room of much better grasses or plants. I have heard the statement made that if ka-moce is pulled up and allowed to dry on the ground for two or three days the cattle will eat it. It is very difficult and expensive to get rid of.

Of late years the sensitive plant (*Mimosa pudica*) has been introduced largely on coco-nut plantations. It is good for the trees, and, if once accustomed to it, the cattle come to like it, and thrive on it. It stands drought well, and its only drawback is that it is covered with small prickles.

Here in Fiji the planter makes a good profit out of his cattle. He must provide them with food, so he sends them amongst his coco-nut trees when these are so old (say about 5 years) that the animals cannot injure them by getting at and pulling out their tender centre shoots.

As no coco-nut cake is produced here or imported, there has been no chance of experimenting with it as a manure, but in other places it is much recommended for the young plants. Here I think the rats would eat it.

The question of letting other useful plants grow between the rows of young coco-nut plants is one which requires careful consideration and must greatly depend upon the locality and the nature of the soil. To allow the original bush to shoot up again round the young plants is decidedly wrong; this had been done with a block on the place I was managing at Taviuni, and, when the bush was cleared away the second time, some of the young coco-nut trees tumbled over; they had hardly any hold in the ground, and, with their long, fairly healthy-looking leaves, could not at first stand up against an ordinary strong wind. I must,

however, say, the varas had been planted very badly; in some instances it looked as if no holes had been dug at all for them. The sun and wind should not be excluded from the young coco-nut plants and a continually increasing space round them, according to their age, must be kept clear of weeds.

Where the nuts are planted about 30 ft. apart, I can see no objection to using the space between the rows for some other useful plants, such as bananas, yaqona (Fiji grog, *Piper methysticum*), tobacco, maize, &c., the profits from which will help the planter to meet working expenses; but if cotton, cacao or sisal hemp are to be cultivated for a permanency on the same land as coconuts, these should be planted some 40 ft. apart.

When it is intended to use the land for pasture, some kind of good fodder plant or grass should be established towards the time when cattle may be allowed amongst the trees. The sensitive plant (*Mimosa pudica*) is at present in great favour in Taviuni; it has stood a good trial, and given satisfaction everywhere. It should be kept short, or the stems become woodeny and the prickles on them harden. The drawback to it is its thorns, which make it necessary for the labourers when collecting nuts to have their legs protected in some way. There is a thornless variety of the sensitive plant in Queensland, but it

is very little known in Fiji. I am told it is more delicate than the common kind, also that it has in some places been known to revert to the thorny condition.

Guinea grass is much recommended by Ceylon planters. It grows well in Fiji.

Paspalum was also introduced to Fiji some years ago; but, in the opinion of planters with the longest experience of it, it is decidedly injurious to the coco-nut trees and should under no circumstances be planted amongst them. I had it growing in a six-acre paddock for about four years, after which time I left the plantation, and up to the end of that time I could not detect any bad effect on the coco-nut trees. What may have happened later I cannot say. The description of the soil must be taken into consideration when choosing what to grow for your cattle.

As far as I can learn from different publications, the process in most countries for gathering the nuts and making copra, is to let the labourers climb the trees, throw down the ripe or nearly ripe nuts, gather and transport them to a shed near the homestead, unhusk the nuts, split them, cut out the copra and, in most estates of any size, extract the oil from it. I do not think this course of proceedings is pursued in any part of Fiji.

Here we let the nuts fall to the ground when they are ripe enough, collect them in heaps, split them and cut out the copra, carry it to and

spread it on the vatas; two well filled bags constitute an ordinary task for a man.

The vatas are the platforms on which the copra is spread out for drying. They are usually wooden frames with reed bottoms, and when it rains the copra is covered with old galvanized iron, canvas, or coco-nut leaves. On larger and better provided plantations the vatas are usually wooden platforms on wheels moving on rails and made to run under a shed when rain comes on and at night time. The object of the planter who sells in the local market appears to me to be to produce an article just good enough to secure the advertised market price. There is really no encouragement here to produce an extra fine article, the merchants will not pay any more for it, though they are not adverse to reducing the price for indifferent copra. Whether it would pay the merchant to grade his copra into two or more different lots according to quality, I cannot say, but I am pretty well sure that if copra of mixed descriptions is placed in a single heap the bad will have a more deteriorating effect on the good copra than that the latter will improve the former.

Results are better when planters themselves ship direct to the Colonies or Europe; and even then the market price quoted for South Sea Island copra is almost invariably lower than that paid for copra from any other place, and generally some £3 or £4 less than Malabar and Ceylon copra fetches.

What is the reason for this state of affairs? Who is to blame, the planter or the merchant?

The answer to the first question is simply this, that Fiji copra as now put on the European market is the poorest article offered there, and consequently is paid the lowest price. The answer to the second question is not so obvious. The planter, or producer, especially if a native or Indian, has not, as a rule, the proper appliances for making good copra; the weather also may be against the work, and the copra may have to remain in the vatas for a considerable time before it is dry enough, and then it has turned a very dark colour. Such copra, when pressed, only gives an oil of bad colour and poor quality. The local merchant takes it, not from choice in many cases, but because he has supplied the owner with goods on credit, and this is the only way in which he can get payment. If the merchant sent such copra to Europe or the Colonies it would not come up to expectations, so he mixes it with some of better quality. The planter himself will do this if he is fortunate enough to be able to. This results in indifferent copra, and the blame lies with the merchant as well as with the planter, but mostly with the former. All the planters cannot always produce good copra, but the shipper can always grade it if he likes, and really good copra can be obtained from Fiji as well as from other places.

To make the copra in the field, as is done

in Fiji, saves transport; there can be no doubt about that point; against it remains the fact that it is not always possible to prevent the copra from getting wet whilst being made or before it can be brought under shelter, and that means deterioration. When bringing in the nuts and heaping them in a shed near the homestead you can choose a favourable time for extracting the copra, that is to say, within a few weeks, and before the kernel begins to undergo alterations previous to the sprouting. It is also more convenient and less expensive to husk the nuts at, and ship the coir fibre from, the homestead, than if the husking is done in the field. As no coir is made in Fiji at present the latter point is not of any importance. When artificial heat is used for drying copra the hard shell of the nut is generally used for fuel. Here in Fiji the shells with the husks are left in heaps in the field where the copra was cut, dried leaves fallen from the trees are piled on top, and the whole lot burned, the ashes serving as manure.

With a fresh wind and good sunshine two days' exposure of the green copra is generally reckoned sufficient time in which to dry it. It is then put in a heap in the copra house to await shipment. Further loss in weight takes place here, and some 40 per cent. is lost altogether in the drying process. Drying by artificial heat is not done in Fiji, except on the

island of Rabi, as far as I know. The copra can be dried in that way in much shorter time than by the ordinary method. I read in "The Consols of the East" the other day that the highest-priced copra was obtained by drying it in the sun for six days.

In cases where the copra and coir are sent away, and the shell used for fuel, and consequently nothing returned to the land, it becomes absolutely necessary to apply some kind of manure in order to maintain the productiveness of the soil.

It appears to me an anomaly that the owner of one of the largest coco-nut plantations in Fiji, on which is also a dairy of very considerable size, sends all his copra away, when he might extract the oil, export that, and use the poonac (coco-nut cake) for feeding the dairy cows with. Denmark could not produce butter of such superlative quality without using poonac for the milking cows. An experiment has shown that by adding 21 oz. of poonac to the ordinary daily food of a cow which produced 28¾ lb. of milk containing 16 oz. of fat, the yield was increased to 35½ lb. of milk (an increase of 23·5 per cent.) containing 20¼ oz. of fat (an increase of 26·5 per cent.). It has also been ascertained that the better keeping quality of the Danish butter compared with that of other countries is to a great extent due to the poonac given to the dairy cows.

Coming to the question of insects attacking

the palms, there are several kinds of these, but as some of them do comparatively little damage as yet, I shall limit myself to dealing with the three most important. In the July number of *The Planters' Journal* appeared a report by the Hon. C. H. Knowles, describing a leaf disease on Vanua Levu, which is also met with on Taviuni and, I believe, on others of these islands. It will be unnecessary for me to repeat his report here.

The Viti Levu leaf disease has done damage to such an extent that planting and cultivating the coco-nut palm was practically given up many years ago on this island. Fortunately it has not as yet spread to any other parts of the group. There are a good many trees scattered about on Viti Levu, but they have hitherto borne a sickly appearance, producing only a few nuts and in many instances none at all.

It has been established that the disease is due to a small moth not hitherto found anywhere else, of which Mr. Knowles (in 1911) sent specimens to Mr. Bethume Baker, by whom they were placed in the new genus Levuan and named *L. iridescens* (B.B.).

Mr. F. P. Jepson, Government Entomologist, in his report on Economic Entomology, 1911, writes as follows :—

"Every effort has been made to trace the early history of this pest in Fiji. Planters of long standing in the Colony have been con-

sulted, but little help has been obtained from them beyond the fact that the trees are now worse than they used to be. As these insects have increased unchecked for years, one can readily accept this statement. It was thought that much help might be obtained from the natives, but, as is well known, the Fijians have little idea of the passage and reckoning of time. The oldest native inhabitants speak of this disease of coco-nuts as occurring as far back as they can remember, and there are several native superstitions which regard it as a curse for the misdoings of their ancestors in early times."

As long ago as 1877 Mr. J. Horne, who, at the invitation of Sir Arthur Gordon, visited these islands with the object of inquiring into the botanical, agricultural and economical resources of the Colony, made reference to the insect in his useful little book entitled "A Year in Fiji," where he says: "The subject ought to be investigated, in order that a remedy may be found and applied; and if this is done, the coco-nut tree could be increased a thousand-fold in the Colony."

A period of nearly thirty years elapsed before any steps were taken to carry out Mr. Horne's suggestion. As a consequence this moth has continued its ravages, and has multiplied unchecked, and the localities from which it has been reported in Viti Levu show that its distribution is universal throughout the island. In January,

1909, Mr. Knowles, in his report on coco-nut pests to the Colonial Secretary referring to this moth, stated: "In my opinion the effects of this insect are chiefly responsible for the unproductiveness of coco-nuts on this island."

It is believed that Taviuni is free from this pest at present, and it has not been observed by the writer in any part of Vanua Levu which he has visited.

The distribution of this insect has been by no means an easy matter to ascertain, owing to the fact that following a period of activity of a few months there is a quiescent period of several months when no trace of the moth is to be seen. Their disappearance still remains a complex puzzle, as diligent searches for the eggs at these quiescent periods have resulted in complete failure. It was thought that these stages in the life-history of the moth might be spent in the egg state, but careful searches for these among the débris and fibre around the trunks of palms were unsuccessful. It was again thought that possibly the moths of certain generations might at this time of the year migrate to another host plant for a time, and after having there completed a series of generations return to the coco-nut. This moth has, however, never been observed on anything but the coco-nut palm and the Royal palm (*Oreodoya regia*) and of the latter there are a very limited number in Fiji.

New-comers to Viti Levu are at once struck

by the unhealthy appearance of the coco-nut palms on this island. The lower leaves lack the rich green colour which one usually associates with the palm, and are, instead, a dirty brown colour, and, in many cases, resemble dead leaves. Upon closer examination it will be observed that there are numerous transparent lines running parellel to one another in a longitudinal direction from the base to the apex of each leaflet. In many instances the leaflets consist merely of a fine network surrounding the midrib. These transparent lines are caused by the removal of the epidermic cells on the under surface of the leaflets. As has been stated above, the larvæ upon hatching from the eggs, which have been deposited upon the under surface, commence to feed, and travelling in a straight line parallel to the midrib remove a layer of epidermal tissue in their progress.

Strange to say, from the latter end of last year a change commenced to take place in the appearance of the coco-nuts in most parts of Viti Levu. Many of the hitherto sickly looking trees began to put out more and quite healthy-looking leaves, some palms which formerly bore but few nuts are showing more, and others (some of them more than twenty years old) which never set fruit before are now producing nuts.

The chance of combating the pest successfully seems to me now considerably increased.

There has not as yet been sufficient time to investigate the cause of the improved conditions, but it is most likely that some natural enemy which has hitherto escaped notice has increased to such an extent as to become an effectual check to the pest. There may, of course, be other reasons, but whatever these are it must be borne in mind that as the disease has existed and spread during a great number of years without any, or very little, hindrance, the change must be due to something hitherto unknown which has appeared on the scene and made its presence felt. It cannot be the effect of abnormal weather conditions, as these have been much as usual during the last twelve months, nor can it be due to any hurricane, as such has occurred before without showing any specially beneficial effect on the palms left standing.

Mr. F. P. Jepson, in his report on Economic Entomology (Fiji), writes as follows on a "cabbage" eating moth (*Trachycentra*, sp.) :—

"On two plantations at Taviuni it was noticed that there were small clumps of trees which had lost their heads, and only the bare trunks remained. Some of the planters attributed this to the effects of lightning. Upon examination of the fallen heads, large numbers of larvæ and pupal cases were found, as many as 100 being taken from a single 'cabbage.' The tracks of these larvæ were discernible down to the hard part of the trunk,

where they ceased. The whole cabbage was reduced to a fœtid, offensive-smelling mass, and was in a very advanced stage of decomposition. Where the eggs of this moth are laid is not known at present, but probably it will be found to be on the leaf bases where small larvæ have been discovered making their way towards the cabbage. The condition to which those palms are reduced appears to very closely resemble the 'bud-rot' disease which occurs in the West Indies, &c."

The inference which appears to me the most natural to draw from the foregoing reports is that bud-rot is caused by the piercing of the young and tender leaves surrounding the cabbage. Once an opening is made the soft and sweet interior is immediately attacked by bacteria, fungi, and sundry insects.

Mr. Jepson is probably right in supposing the Trachycentra does the initial damage with trees, but as this moth has not been mentioned (so far as I know) by writers in other coco-nut growing countries in connection with the disease, it is most likely that there is something else — animal, bird, or insect — which is to blame. Whatever causes the wound the result is bud-rot.

Although palms killed by bud-rot, if left standing, have ultimately very much the same appearance as those struck by lightning, there is a very considerable difference in the two operations.

Lightning will as a rule shatter one or two trees badly, and those standing close by will be damaged by the heat to such an extent that they get diseased, their tops rot and they die, their stem being marked with a number of brown spots.

Now with bud-rot my experience has been to the effect that a healthy tree standing next to a diseased one does not get it. At the plantation I was on at Taviuni the area on which trees became attacked was limited to some six acres. Here a palm showing the disease would be felled; the next one attacked — probably many months later — would be found at the other end of the block, then perhaps some tree in the middle would suffer, but I never saw two diseased trees standing together, there were always some five or six, and generally more, healthy ones between them. The stems of the trees felled never showed the spots found on those killed by lightning.

Stick-insects (*Phasmidæ*). — "Extensive damage is frequently done to coco-nuts in some parts of the group by the so-called 'stick-insect,'" writes Mr. E. P. Jepson in his report on Economic Entomology of Fiji, and continues as follows: "These insects belong to the family *Phasmidæ*, are extremely voracious, and will often completely defoliate a tree, leaving only the midribs. Dr. Sharp refers to them as follows: They are all vegetable feeders and

are extremely voracious, so that a pair will destroy a great quantity of foliage; they are consequently in some parts of the world classed among injurious insects. In Fiji and the Friendly Islands, *Lopaphus cocophagus* eats the coco-nut foliage and causes a scarcity of food, so that it becomes a matter of necessity to destroy these insects. Phasmidæ have been reported as causing considerable damage to the coco-nut plantations on the island of Cicia; they are also common at Savu-savu Bay, Wainunu, Suva, Levuka, Mango, and in the Lau group.

The damage done by Phasmidæ is very characteristic. Irregular, clean-cut patches are eaten out of the leaflets by means of the very powerful biting jaws with which the insect is provided. Sometimes only a few leaflets are attacked; at other times the damage may be extensive. The writer has seen a palm completely defoliated, only the midribs of the leaflets remaining.

These insects are entirely nocturnal in habits, and conceal themselves under the folded leaflets of the coco-nut palms during the daytime. There are several representatives of this family in Fiji, the two most important being *Phibalocera pythonius*, Westw., and *Lopaphus cocophagus*, Newp. The former, a large green wingless insect, attains a great size, several specimens taken having been over 9 in. in length. The latter is a slender brown insect

about $4\frac{1}{2}$ in. long. Concerning these two insects Mr. Kirby writes :—

"The two latter species are common in the South Sea Islands, where *Lopaphus cocophagus* sometimes commits dreadful ravages in the plantations of coco-nut trees."

The Fijian natives, to whom these insects are known as "mimimata," regard them with a certain amount of awe, on account of their power of ejecting a stinking fluid, said to be very acrid, and supposed, if it strikes the eye, to cause blindness. No authentic instance of blindness caused in this fashion is known in Fiji, but it can be well understood that should this fluid strike the eye it would cause a considerable amount of temporary discomfort. This liquid is secreted in the glands of the thorax. Birds are known to prey on Phasmidæ to a very large extent, and there are many instances of parasitism by other insects. Very few eggs are produced considering the large amount of food consumed by these insects. The eggs are deposited by the females at random from the top of the tree on to the ground.

The adult of the *Phibalocera pythonius* is a large, green, bulky bodied insect provided with powerful mandibles. The length is stated by some residents in Fiji to reach 14 in., but none in this collection exceed $9\frac{1}{2}$ in. The breadth is $\frac{5}{8}$ in. This insect is entirely apterous, and so, in order to gain access to the foliage,

has to climb the trunk of the palm. This fact can be taken advantage of by preventing its ascent by means of some contrivance or preparation placed around the trunk. Representatives of this family have the power of reproducing a lost limb.

The *Lopaphus cocophagus* is much smaller than *Phibalocera pythonius*, rarely exceeding 4½ in. in length, and ¼ in. in breadth. The body is slender and brown in colour. The wings and tegmina are very small, and the former cannot be of much use in flight. The eggs of this insect have not yet been found here.

Probably the most satisfactory, and at the same time least expensive, method of dealing with both these insects, where the damage caused is extensive, would be the following: As has been stated above, Phasmidæ are nocturnal in habits, and during the daytime find shelter beneath the folded leaflets of the palms. If broken and fallen leaves of coco-nut trees, as well as all débris, such as husks, loose fibre and cut weeds, &c., are collected and made into a heap beneath each palm, and when dry set fire to, the smoke will cause the insects to release their hold of the leaflets, and falling to the ground they will either be destroyed by fire or will form an easy prey for birds. There are still many points of interest yet to be discovered concerning these insects, and also the methods for their control.

With reference to these insects I may say they do not appear to be very numerous on Taviuni, and on the plantations I managed I only found one tree attacked (out of a total of some 8,000), and I was constantly on the look-out for more. It is remarkable that there were other palms at the usual distance round the one attacked, the leaves in some places touching those infested, yet the insects did not injure those other trees—at least not during the five years I observed them. I could see no difference whatever between the height of this infected palm and that of the surrounding ones, the stem was slightly thinner; it appeared to be about thirty years old; its leaves were not of a healthy colour, and generally half eaten away by these insects, the midribs always being left. I asked a number of old Fijians if they could tell me the reason why this palm in particular suffered, and they all seemed of the same opinion, namely, that the sap of that particular tree was "sweet." Whether it was of a different species of coco-nut from the surrounding ones the natives did not seem to know. This may or may not be the case; I was, however, not qualified to further investigate the matter and settle this point, but it appears to me very probable that some varieties of coco-nut palms may be found which these insects will not attack.

Since writing this article, another troublesome insect has developed into a pest on the

banana plantations and will most likely spread to the coco-nut palms. This is the scale insect, known as *Aspidiotus destructor*, Sign.[1]

In Bulletin No. 5, "Some Preliminary Notes on the Scale Insect Infesting the Banana in Fiji," Mr. F. P. Jepson has gathered and published the following information :—

Froggatt says, "This scale insect was described by Signoret from specimens sent to him from Reunion, where he says that this species does great damage to the coco-nut groves on the island."

Banks says, "*Aspidiotus destructor*, Sign., is by far the most pernicious of the scales which attack the coco-nut in the Philippines. It occurs most frequently on the young trees having one to five years' growth, in many cases completely covering the under surfaces of the leaves, giving them a characteristic yellow tinge."

Doane, in his notes on the scale in Tahiti, says, "It is one of the greatest pests upon coco-nut palms in the Society Islands. Here it infests both old and young trees in a similar manner, but on the old trees, besides the foliage, it spreads over the flower spikes and even the coco-nuts become coated with the scale. Many trees have been killed, whilst others, on account of this infestation, bear no nuts, and on some islands it has become so

[1] See p. 265, *et seq.*

bad that no nuts are gathered. At one time it appeared as if all the trees would become barren, as all the young palms become smothered with the scale from the older infested trees."

This scale is known as the "Bourbon Aspidiotus" in the West Indies, and it is recorded in many of the islands out there.

Urich, in "Preliminary Notes on some Insects Affecting the Coco-nut Palm," Trinidad, 1911, tells us that this scale is always associated with ants (*Azteca chartifex*, Forel), which, being exceedingly fond of the honey-dew secreted by the scales, protect and probably propagate them on purpose to obtain a food supply. He suggests getting rid of the ants by means of kerosene emulsion and thinks that the scale insect may be left to its parasites.

Froggatt remarks that although the members of the Aspidiotus group of scales are usually hard and horny, this particular species is much thinner and lighter in texture than most species, and is therefore much more readily destroyed by unfavourable weather conditions and by the attacks of parasites. It is also much more amenable to treatment with spraying or fumigation.

COCO-NUTS IN THE SOLOMON ISLANDS.

The following interesting account of a trip taken by Mr. Stuart S. Garrick, of Samoa, was published by the *Samoanische Zeitung* a little time back :—

"I arrived at Guadalcanar Island the same evening, where we anchored. Here is situated the head station of the Malaita Company, on a small island. Early the following morning the steamer called at Kaukau plantation, 600 acres planted; also at Mauronia, 600 acres: the former is quite a new plantation. At the latter the steamer loaded copra and returned to our previous night's anchorage, where I went ashore and visited Aola, a small plantation of 120 acres of 8 year old nuts. Here we took on board about 20 tons of ivory nuts from a German company who have a collecting station in the vicinity. Ivory nuts are grown in swampy land, they take seven years to come to maturity, and give one very big crop. The present value is about £12 10s. per ton in Sydney. The natives receive trade goods equal to a few shillings per bag only, so you can imagine the profit there is in them. They are shipped to Hamburg, and are made into buttons, serviette rings, &c.

"Early next morning the steamer arrived at Ilu, a very large leasehold property. This is what is known as grass country, and is fairly expensive to cultivate. One grass plain is 1,700 acres in extent, covered with lalang grass, which grows to the height of about 6 or 7 ft. It is only in its infancy, and a large sum of money will have to be expended in order to comply with lease terms, as along this coast the firm of Messrs. Lever Brothers hold some 200,000 acres, on a nine hundred and ninety-nine years' lease. An enormous kerosene traction engine is used to draw the ploughs in addition to horse traction, which latter, however, is very expensive, as the animals are unable to work for more than about four hours a day, and operations have been at a standstill for about six weeks, owing to the excessive rains. The nature of the ground is, of course, very moist and tough, and the more I saw of the grass country the less I liked the proposition of working it. The manager drove us over a large block of this country, and then through the adjoining property of Tenaru, a large portion of which was grass country. The general manager of the plantation informed me that it was his intention to try explosives about every 30 ft. between the rows of coco-nuts, as he was in hopes that this would loosen the soil considerably. This land, as soon as planted, is sown with Mauritius bean, sweet potatoes, or a convolvulus which very

much resembles one of our local creepers. The former and the latter are ploughed in every year, whilst the sweet potatoes are used for feeding the labourers.

"After passing through Tenaru we arrived at Lunga, a considerable portion of which is also grass country, and judging from results here as compared with those obtained on bush-felled and coral country, the growth does not compare favourably. The cattle on the latter two estates were grown beasts and in splendid condition. A portion of this latter estate is fourteen years old, and a considerable quantity of copra is shipped from it by every steamer.

"The next property visited was Kakoon, upon which there were several hundred acres already planted.

"The next call was at Mamara,[1] one of the plantations of the Malaita Company; here we loaded cotton, but, unfortunately, the company being very short handed only a portion of the crop had been picked. The next call was at Tasavarong, another property of the Malaita Company, thence to Dormar, which is certainly the pick of the land.

"After leaving the Guadalcanar coast the steamer went to the Russell Islands, generally known as Cape Marsh, and looked upon as the pick of the land in the Solomons. The following morning, after arriving at night, I spent a

[1] Where Mamara cotton, a rival to Caravonica, was originated.—H. H. S.

couple of hours at Banika Estate, 1,400 acres planted. The manager was most assiduous in showing me all he possibly could in a short time. In the immediate vicinity the company own Ufa, 800 acres planted; and Louvie, 350 acres. On the same island as Banika the Malaita Company has a very fine property. Copra is being collected from all these estates, which in a few years will be in full bearing.

"Our next call was at Pepesala and Kalan. The former is 1,700 acres planted, and the latter about 500. I visited the latter first, and from this, on rotten coral land, the best coco-nuts are procured; they commence to bear after five years. Here I also spent some time inspecting the most recent mechanical dryer, which is giving excellent results, turning out dry copra every twelve hours. I am not able at the present to give you full particulars as to the construction, but I may just mention that it has four small furnaces (two at each end), in which a minimum amount of husk is used, and at night a few logs of wood are thrown in, which keep it alight all night. You will therefore understand that the labour required is almost infinitesimal.

"The general manager of the plantations, who lives at Pepesala, put a horse at my disposal, and I spent some two hours riding over the estate. I was particularly interested in the rubber planting, comprising, in three different parts of the estate, some 40 acres. The trees

are planted 15 × 15, but it needed little more than a glance to satisfy me that the country is not suitable for rubber cultivation. Trees 20 and 24 in. in circumference, on being cut with the knife yielded scarcely any latex, and then of a very watery description. In some instances, where trees have struck an extra rich patch of soil, they gave better results. The manager asked me for my opinion, and I told him what I thought of the trees, which he said exactly bore out the one he had formed some considerable time ago. After the way in which our trees are looked after in Samoa you would doubtless be surprised to see the number of the stems that have been left. In one instance I counted up to six.

"Our next call in this group was at West Bay Estate, on the other side of the peninsula, a property of 620 acres planted, which is also a very fine property. The steamer then came to Rendova Island, 650 acres planted, the returns from which are already proving more than highly satisfactory.

"Gizo Island, the old Government port of entrance and departure, followed. Messrs. Burns Philp have a station and plantation here, and there are also many small plantations in the vicinity. This is about the prettiest place in the Islands, as it is dotted all round with numerous small islands, many of which have been entirely cleared and planted with nuts, now growing in good shape.

"The final plantation that I could have visited was at Vila, but we only stopped an hour, so had no opportunity of landing. The country is fine and level, with very little swamp, and planting was first started some two years ago. This is what is known as an Employees' Company, Lever Brothers having half the interest, and the employees in the firm being allowed to take up the other half of the shares at par. The whole concern is managed by Messrs. Lever Brothers, the company, of course, having the advantage of all their knowledge.

"Stanmore is another Employees' Company, upon which only a small amount of work is yet done.

"There were many other properties and plantations which, of course, were not visited, as they were only in their infancy, there being no copra or other produce to collect.

"The steamer returned to Gavutu on Friday, the 18th, and left again the same afternoon for Sydney, at which port we arrived at 8 a.m. the following Friday, after a very pleasant trip.

"In giving one's impressions it is, of course, difficult to give more than an outline, and it is quite impossible to relate the very interesting conversations I had with the various employees, from the general manager of the company downwards. I can say, however, that Messrs. Lever Brothers have a great future before them in the Solomons.

"Speaking generally, I would say that land can be planted in the Solomons for 45s. an acre. This, of course, does not include the cost of the land. Planters should compare this with our cost in Samao.

"Felling costs 8s. 6d. The Malaita boy simply revels in this work: he likes taking life, even if it is only the life of a tree, consequently competition between them is very great.

"Springboards are used when felling the big timber. They are about 3 ft. 6 in. long by 6 in. wide, and taper from, say, 4 in. to 2 in. The wedge end is shod with a piece of iron, almost similar to a horse-shoe, with the spike sticking up, which catches in the top of the cut, making the foothold quite firm.

"The labour question, of course, is as much a worry in the Solomons as it is in Samoa, and high prices are now being paid for recruiting boys. £10 is looked upon as the usual figure, but I have heard of cases in which £12 is being asked. Most of the boys are being recruited from Malaita Island. This does not, of course, refer to Messrs. Lever Brothers, who have their own recruiting vessel, and I should think that the cost to them would not exceed £6 per head.

"There is talk now of making the Islands a Crown Colony, it is then hoped that the British Government will give permission for the importation of Indians. Why this should be I do not know, as it is all under British

control, but it is said that a Crown Colony can give guarantees which a Protectorate cannot. It looks very much like red tape. It is imperative that outside labour be obtained, as the islander is going very fast. From what I saw of the boys they are fine workers, and give very little trouble; the rate of pay is 10s. a month, length of contract two years. Kaikai, 1½ lb. rice per diem, unlimited quantities of sweet potatoes, &c., and a ration of meat twice a week. I reckon that the cost per unit is very nearly 50 per cent. less than the coolie costs us, reckoning his wages at 20s. per month.

"There is no chance of obtaining freehold land now in the Solomons, and leases are also difficult to obtain owing to the Government Resident, of which it is not necessary to speak.

"The Germans at Bouganville Island are encouraging settlement, and give so many hectares of land to *bona fide* settlers, and help them to procure labour. In this way many companies have gone there which, had land been obtainable in the British Solomons, would not have done so.

"There is nothing in the nature of a town right through the group. Messrs. Burns Philp and Co. and Lever Brothers have stations here and there on the various islands which, in the majority of cases, are freehold.

"The class of men employed struck me as leaving little to be desired; the firm give them

every encouragement, treats them well, and pay very fair salaries, and in no case did I hear any complaints against the firm by the employees.

"The following may interest you, as it bears out what Mr. Harman reported as a result of his recent visit to one of the Government stations in Ceylon.

"As regards pests, Messrs. Lever Brothers' general manager reckons it takes from 10 to 15 per cent. of the labour to cope with these, the chief of which are the Elephant and Baby pest, Froggatt and Rhino beetles. The Froggatt is a nuisance, and takes a lot of looking after. I saw little or no damage done to trees by the Rhino, and have samples of two Elephant varieties."

REMOUNTS FOR THE ARMY.

CAN THEY BE RAISED ON COCO-NUT ESTATES?

WITH the advent of the automobile, and the rapid reduction in the number of horses in use, especially in crowded centres like the city of London, the question of keeping Army remounts up to the required standard, both as regards quantity and quality, continues to agitate the thinking public, and to cause anxiety to those directly responsible to the various War Offices and Governments for this important work.[1] From all we can gather,

[1] Take the United Kingdom, for instance, in the debate on the War Office Vote in the House of Commons on Thursday evening, July 4 (1912). Mr. Amery, Unionist Member for S. Birmingham, asked whether "sufficient horses were now available, in a sound condition, to take the field at once? Had the Secretary for War got the 86,000 horses required for the mobilization of the Territorials, or the 18,000 horses necessary for the troops which would be left at home?"

General Sir Reginald Pole-Carew, representing Cornwall, who followed, said that, if the question of the shortage of horses was an ever-growing difficulty, why should not the War Office acknowledge openly that there was not a single mounted unit fit to take the field until they had filled it up with other horses? (Hear, hear.)

Colonel Seely, who had recently succeeded Lord

supplies are none too plentiful now that we are at peace, so what it will be when an important war comes along is easier to imagine than to remedy. We will give one example out of many. At the annual meeting of the Automobile Association Mr. Joynson-Hicks, as chairman, announced that their total membership was 48,620, but as 4,135 fresh names had been added during April, May and June (1912), a total of 50,000 members would soon be reached, each one of whom, we would add, are more interested in motors than in horses. Mr. Hicks's subsequent remarks confirm this impression. "In ten years," he told those present, "5,000 hansom cabs and 1,000 horse tramcars have disappeared from the streets; yet in spite of the fact that some 50,000 horses have thus been removed from London, &c., &c."

Ten years takes us back to the Boer War,

Haldane as Secretary for War, replied that "the provision of horses at that time (1906) was in a most unsatisfactory state. The situation to-day was that the peace establishment was practically complete. To complete the war establishment a very large number of horses would be required, but there was an ample supply of all types except the light draught horses" [these are just the horses that we believe could be raised on coco-nut estates], "which used to be adequately supplied by omnibus companies, and whose numbers were dwindling in this as well as in other countries. Horses must be obtained somehow, and the necessary measures were being put into final shape for submission to the Treasury, and he did not think the House would grudge the expense."

when, it will be remembered, the horse-omnibuses were still a force in the land. Even then those connected with the remount department had to scour the Continent and elsewhere to obtain the horses they required, until jokes and caricatures galore at the expense of some of the animals and their purchasers filled the comic papers. If this was the case ten years ago, what would happen if we went to war next year or soon after? The automobile may have displaced the horse to a large extent in the art of peace, but it certainly has not done so in the art of war.

In the face of this dilemma we would suggest that those whose business it is to do so should consider the possibilities of encouraging horse-breeding on coco-nut estates, especially the large ones, say, 1,000 acres and upward, out in the Tropics.

In the section in this book on "Cattle" (p. 327) we dwell in detail on the possibilities and profits that accrue from breeding and fattening cattle and hogs on coco-nut estates. What we there show can be done with cattle could, we feel certain, be done with horses once the demand for them is assured. When one thinks of the herds of these animals, descendants of those which first came out with the Spaniards and at one time roamed wild in the tropical and sub-tropical zones, and flourished and increased amazingly, we cannot help feeling that with the protection of the palms from the

sun, with the care of the stockmen, and with ample green fodder augmented with poonac, maize, &c., horses could be bred economically and advantageously, both for the estate owner on the spot and the Army authorities at home and elsewhere.

Once bred, the question of transport is nothing; we are not likely to need the animals for fighting in England itself, and as regards elsewhere we could remove them as easily—and if at war with a European nation perhaps far more easily—from the Tropics to the seat of war, as if we had them all at one centre. On the contrary, with the breeding centres dispersed throughout the world, in the same way as our coaling stations are, the chances of having total supplies cut off would be reduced to a minimum. If we were cut off from Jamaica (already a well-known centre for horse-breeding) or any other spot in the West Indies, we might be able to go to Southern India, to the Malabar Coast, Malaya, tropical Australia, &c.; wherever horses and coco-nuts alike can be bred, there should the Government consider the possibilities of making it worth the planters' while to breed horses necessary for our remounts. Ceylon, some maintain, is unsuitable for cattle breeding, so is Nyasaland, at any rate, until the tsetse-flies are exterminated.

The recent outbreak of foot-and-mouth disease reminds one that, should it be found

necessary for the Government to establish or to subsidize large horse-breeding establishments with many animals on one farm, glanders or other serious trouble might break out just when the animals were most needed, whereas, with the establishments spread over the Empire, should trouble break out at one depôt supplies could then continue to be drawn without interruption from other estates free of infection.

We are no authority on horse-breeding, but we have had a good deal to do with those who have been brought up to the business in the Tropics, and we feel certain that, at least from our own Government's point of view, the matter is worthy of consideration ; whilst from the planters' point of view, once there is the demand for the horses, as there is for the cattle, hogs, &c., we discuss in our book, then to breed horses as well as the other stock on their estates would help to increase their profits and distribute their risks.

According to the *Tropical Agriculturist* the Ceylon Government is about to start a horse-breeding farm in the neighbourhood of Ambepussa railway station. This establishment should offer immense facilities for such work as has been indicated above. Mr. A. L. Hutchison, London Correspondent to the *Times of Ceylon*, in commenting on and supporting our suggestion, called attention to the success of the pony-breeding establish-

ments on the island of Delft, off Ceylon. "My pony, 'The Birdcatcher' (14.2)," he goes on to say, "which once had a great reputation in Haputale, was a Delft pony. He was hard to beat in the matter of stamina, and there was simply no tiring him. He was an Arab, and as the late 'Skip' Shelton used to say of him, he was 'a perfect miniature charger.' Something heavier and more of a weight-carrier could doubtless be bred."

Meanwhile, the advice we give in this book, when urging estate owners and land proprietors to take up cattle-breeding, sheep-farming, and hog-raising, so far as their means will allow, has been given none too soon. On every side we are constantly hearing complaints of the shortage of food supplies, particularly of meat. Berlin had what almost amounted to a riot, owing to the high prices demanded; whilst even Switzerland, we believe, is, or was, importing Argentine cattle. In the United States, here in England, and elsewhere, the rise in the cost of meat and other food-stuffs is eating a big hole in the increased wages of the public; so much so that much as wage-payers are already complaining, it seems unlikely that the present level of wages has anything like touched its highest. All this naturally affects the cost of machinery and manufactured goods sent by the meat-buying countries to the Tropics. If, therefore, estate owners can see their way to increase the

world's meat supply, they will not only benefit the public generally, but, by lowering the cost of living, or at least by helping to discourage its going still higher, they will benefit themselves in more ways than one.

The Ceylon papers, some time back, in speaking of the scarcity of meat, reported that at Matale prices showed a rise of 120 per cent. on November 12, 1912, for on that day there was only one ox available to supply eighty planters and their families on the estates, as well as the general public in the town. We feel that, in face of such news, one and all of our readers who can do so, will at once begin to seriously consider the rearing of cattle and other stock for supplying their meat to those requiring it, in the same enthusiastic and practical manner that they have done and are doing with the planting of rubber and coco-nut palms for their produce.

Meanwhile, with regard to the supply of remounts for the British Army, matters do not mend. Mr. Walter Runciman, M.P., President of the Board of Agriculture, speaking at the conclusion of the Van Horse Parade held annually on Easter Monday (1913) in Regent's Park, London, told his hearers that a year ago a Government publication put the deficiency of young horses at 200,000, and then he added: "*It is vastly greater to-day.*"

Colonel Seely, M.P., Secretary for War, who also spoke, owned that it was a fact that

the Government was faced with a great difficulty. The number of horses available for peace times did not come up to the requirements of traction in war times.

Meanwhile, the *Daily Mail* reminded us, at the beginning of the year, that the horse-breeding season starts about the end of March, and the one for 1913 promised to be much the most disastrous known. Small farmers have quite given up horse-breeding. The English Government, unlike the German and French and Austrian Governments, has done nothing to remedy the defect. Unless something is done the transition period, which Colonel Seely mentioned in his speech, will end in the extinction of the British war horse. The horses bred under the development grant scheme go for the most part abroad.

We feel justified, therefore, in again calling attention to the matter, and asking those more capable than we are to decide whether remounts for the Army cannot be raised on coco-nut estates. In face of the above statements, made, it will be noticed, by the highest authorities, the question of raising remounts in the Colonies should not be allowed to rest.

Whilst on this subject of stock-raising on coco-nut estates it may be of interest to add that, according to the *Journal of the Board of Agriculture* (England), it is clear that when coco-nut poonac was fed to cattle the butter made from their milk was much firmer; those,

therefore, making butter in warm countries may find coco-nut cake of considerable advantage as a feed. These experiments were carried out at Wye Agricultural College. We should be interested to know how similar experiments carried out with poonac fresh from the press, if fed to cattle on the coco-nut estate itself, would compare with above.

Speaking of this reminds us that cream separators are now seen working in many big cities in India. They make a large quantity of separated milk available for use. Fuller particulars of the above will be found in the January (1913) issue of the *Journal of the Agricultural Institute*, Pusa, India, and are worth noting.

FARMING WITH DYNAMITE.[1]

WHILE I have long suspected the possibilities of explosives in connection with agriculture, especially in the Tropics, I have only been able during the last twelve months to satisfactorily demonstrate how very useful dynamite, and the other "ites," can prove, when used with discretion and by trained natives or Europeans. By their use both time and money can be saved, and better work done, both as regards the soil and the crops.

As regards the handling of these high explosives by natives, I would consider that any race or tribe which is intelligent enough to be trained to tap rubber trees, or extract pulqué from the maguey plant, as is done under the direction of white supervisors, could be trained to handle these explosives, drill the holes, and pack in the cartridges under the same class of white directors as those who superintend the tapping of rubber.

On account of the now widespread use of

[1] The first portion of this section consists of a paper by Mr. Hamel Smith, read at the Third International Rubber Conference, held in New York, 1912, and now reproduced from the *India-Rubber World*, New York, of April, 1913.

explosives on cultivations, I would first state that if I do not include the names of the leading centres which have lately been using or experimenting with them for breaking up soils (some of the farmers in the Western States of America have, I understand, regularly blasted their ground for twenty or thirty years past, and obtained bumper crops thereby), nor mention the names of all the leading journals that have been good enough to open their columns to discuss the matter, it is not for want of appreciation on my part of the important share that they have taken in helping us to become "at home" with the use and handling of explosives, but for lack of space and time at my disposal and yours. I must, on the contrary, be far more brief than pleases me, for this is a subject which, the more it is discussed, the more one can realize what can be done with dynamite, and hence the more one would like to say on its use.

Dynamite or other explosives—and for the sake of brevity let me say "right here," that every time I use the word dynamite, I mean to imply "or other explosive if more suitable"—can be used with advantage in agricultural industries for the following reasons :—

(1) To break up hard or virgin soil to facilitate ploughing ; and especially to break up the under-crust, when present, which no plough could penetrate, at any rate no plough used by the average farmer or planter.

(2) To blast out for removal, boulders, or rocks, and especially tree stumps, whereby not only is the risk of root disease removed, but, what is of great importance, the ground is left in a state to be easily and properly ploughed; which otherwise would be impossible in a satisfactory manner, if the stumps or rocks were left *in situ*.

(3) For clearing the soil of pests, destroying ants' nests, or rabbit warrens, &c., as well as for regenerating and aerating hard or worn-out soils generally—as the sugar-lands on some of the West Indian estates, which are not ploughed, but only hoed; *i.e.*, the surface only is scratched over, but the hard pan sub-soil is left year after year, and so becomes water-logged and airless; hence dangerous.

(4) For throwing up the soil for drains, especially deep gullies, and facilitating its removal by ploughs or hand.

(5) For making holes for tree planting, and at the same time loosening the soil, which is a great advantage; also for fence-post holes, or for setting uprights for buildings, &c., in position.

(6) For well-boring or well-torpedoing—*i.e.*, for increasing the flow from an artesian well by exploding a charge at the bottom to widen the aperture, and break up the ground, in order to let further supplies of water (or oil, if an oil-well) come through.

As time goes on, many other uses on the

estates will no doubt be found, but as I do not pretend to have an exhaustive knowledge on the subject, I think I have said enough. Of course, I do not intend to touch on the use of explosives for mining, since I speak only from the agriculturist's point of view; nor even of their utility for removing large masses of rock or soil for making estate roads, as the latter, although not uncommon, is too big and dangerous a task for the average planter, and should not be carried out without consulting an expert, one of whom nowadays is to be found at all large centres, especially in the neighbourhood of mines.

"It must not be thought that dynamite obviates the necessity of top ploughing," very truly points out the *Queensland Agricultural Journal*. "Far from it. The plough must be used just as much as ever. The only difference is, that the dynamite expends its disintegrating force in the sub-soil, which is never touched by the plough, so that one is not merely planting the crops in the same soil year after year, but can, by its use, enable the crops to draw up their nutriment from below." Where clay sub-soils form a water seal, the use of explosives, if correctly applied, breaks up the clay strata and so allows the accumulated and stagnant water to pass through (at the same time the explosion kills myriads of harmful lives), and dissolving the plant foods in the lower, and hitherto inaccessible strata, liberates

them in such form that they can be drawn up by capillary attraction, and pass through with the now non-stagnant water to be assimilated by the crops. May I remind you of the need of regular, adequate supplies of water at all times, if you want good crops. Water is necessary, and therefore should constantly be at the disposal of the crops (provided, of course, it is not in over-supply), to convey the plant's food in soluble form up to the crown. The quantity of such food assimilated or digested by the plant is roughly proportional to the amount of water which it absorbs—provided of course, that the food is there to be absorbed ; but the food alone is no use, without the water it cannot pass up the trees or plants and nourish them.

"Farming by dynamite," wrote the (London) *World's Work* in April (1912), "has gripped the United States and is spreading through Canada and Mexico like a prairie fire. The farmers who have tried it, swear by it, and are upheld by the leading authorities in agricultural science." I can confirm this from the Tropics. Since I first drew attention to the use of high explosives in tropical and sub-tropical agriculture, by reviewing a book ("The Book of High Explosives," published by Nobels' Explosives Co., Ltd., of Glasgow), I have received innumerable applications for copies of the book and further information on the subject, right up to the time of writing these

notes, which I stopped doing to order a copy to be sent to a cacao planter in the State of Bahia, Brazil. The *Queensland Agricultural Journal*, already quoted, evidently found the same thing, for the editor writes: "Since the publication of our articles on the value of dynamite as an aid in clearing land, and to subsequent agricultural operations, judging by the numerous letters we have received from farmers and fruit growers seeking further information on the subject, much interest—we might almost say enthusiasm—has been aroused in many parts of the State in connection with the use of dynamite on the land." Elsewhere the *Times of Ceylon* quotes the following instance of its use for rubber planting by a Kelani Valley (Ceylon) rubber planter, using only ordinary dynamite cartridges: "First of all he used a quarter of a cartridge, then a half, and then a full one, and kept data of the area of ground disturbed when the quantities of dynamite had been fired. The plough only breaks up the top surface, so that the water mingles and dissolves the plant nutriment to a depth only of a few inches. The sub-soil, however, remains intact, and the roots of the crops have to feed upon what they can obtain from the land broken up by the plough. But breaking the land up by dynamite disturbs it to a depth of several feet, letting in the water which dissolves the essential nutriment, while the roots are able to descend to a greater depth

and thus secure their fill of food. Again, the roots are allowed to grow downwards and not laterally; thus they do not encroach on the feeding areas of the adjacent trees, which is the case when there is only a top shallow layer of porous soil.

"The planter in question, we understand, has applied the method to five acres of land and planted rubber trees therein. It is, of course, too early yet to judge the results in the growth of the plants. If the results are as good as anticipated it is very likely that the method will be widely adopted in Ceylon. Ordinary dynamite cartridges were used in this case.

"Now that a local planter has started the method here," continued the paper, in its comments on the experiment, "it will not be out of place to quote one section of a recent article on the subject which is of especial interest to planters: 'Possibly what at first sight appears to be the strangest application of dynamite is for the purpose of planting trees, yet its success in this connection is peculiarly remarkable. When a hole is made with a spade the surrounding soil is left in its hard condition. The result is that the roots find it difficult to start. They are cramped in the tight quarters of the hole and cannot pierce the surrounding hard wall of earth. Under these circumstances growth is appreciably retarded for a considerable time. With

dynamite a large clean hole is blasted out and, in addition, the soil on all sides is loosened for five or six feet. When the tree is planted the young and tender roots force their way without effort through the crevices, sucking up nourishment, and commence to grow from the moment they are set, without any retardation whatever.' Those qualified to speak upon the subject are of opinion that this will bring trees forward at least a year sooner than those planted under the old conditions."

"A new profession has arisen of expert dynamite farmers," says the *Wealth of India*, when commenting on the article in the *World's Work*: "Dynamite is used for planting trees. The spade-made hole leaves the surrounding soil in a hard condition, and the roots find it hard to start. With dynamite a large, clean hole is blasted out, and the soil on all sides is loosened for five or six feet, thus enabling the trees so planted to grow twice as quickly as those set in the usual spade holes."

"We heartily commend the subject of 'Farming by Dynamite' to our readers"—writes the editor of *Grenier's Rubber News*, at Kuala Lumpur, right at the heart of the plantation rubber industry in the Far East. "The consensus of opinion, at least among planters of the Federated Malay States, is that clean-clearing, which means the removal of all stumps and timber, is of paramount importance, and we feel sure that a perusal of the

methods discussed" (in an article they published) "will convince planters that at last there is material available to accomplish the work expeditiously and economically."

"In South Africa," reports the *Home and Colonial Mail*—well known throughout India and the East—"experiments in ploughing by dynamite are becoming quite popular. It is claimed that operations can be carried out without injuring crops, and demonstrations are now taking place all over the Union with the object of fostering agriculture. The cost per acre is said to work out at between £2 10s. and £5, according to the nature of the soil and trees. Dynamite can be used for ditching, for constructing irrigation furrows, and other farming purposes."

All the leading papers in the rubber producing world, as well as those devoted to planting interests elsewhere, recommend attention to the use of dynamite for estate work. Its use especially appeals to me for out-of-the-way sections, and particularly in Latin America, where the transport, even of the lightest make of ploughs, is difficult and costly, often impossible. In centres where the *tsetse* or other pest discourages the use of draught animals, the use of explosives should rapidly increase. Possibly the shocks, if not the actual explosions, might diminish the pests, especially if steps were taken to attract them to the spot by bait, in the shape of food to

which they are partial. In locust-infested soils, the numbers of these pests, at all stages, even when in flight, could be greatly reduced by organized explosions to greet them with a *feu de joie* whether in the soil as grubs or flying over it. But there is no need to extend the list. You whom I am addressing are far more able than myself to think them out. I would, however, say in conclusion that planters of coco-nuts, fibres, Ceará rubber, and other crops which can be grown to advantage, when scientifically cultivated, in almost semi-arid districts, will find the use of explosives a great aid, as the following letter, written from Kalkudah, in the Eastern Province of Ceylon, to the editor of the *Times of Ceylon* (see their issue of June 20, 1912), tends to prove:—

"I read with great interest the articles *re* 'Farming with Dynamite' in the *Times of Ceylon.* I believe this method will gain popularity in the Eastern Province, as there is a slab of coral from the coast here to one-and-a-half miles inland, or further, and this runs from 2 to 9 ft. below the surface, in some places measuring 18 to 24 in. in thickness. It is not porous, but in some parts is soft and limy. There is water immediately below this slab, but the coco-nut roots cannot get to the water, and the trees are therefore greatly affected by the drought, and large sums of money have to be expended in watering plants. One notices patches of coco-nuts, old enough to give large

crops, looking sickly, with not even a blossom on them. This is mainly due to the existence of this slab, which had not been broken through before planting out. Dynamite blasting will do more for these than tons of manure. A hole drilled in between every four plants through this slab and blasted with dynamite will crack up this slab, and enable the roots to find their way to the water which is just underneath it.

"Again, one finds that after rain the water remains in some places for weeks on the surface, affecting all the trees or plants in that area. This, too, would not occur if the slab were broken up, as the water would find its way through the cracks. In some places where this slab was broken through before planting out, the plants require very little watering, and the bearing trees are healthy and full of crop even during the severest drought. The method used in these places is to cut down to the slab and break it with pick-axes, at a prohibitive cost. If holes could be drilled and dynamite used, the breaking up of the slab will be much more extended and the cost less than half. Perhaps the cost of holing with dynamite and planting will be slightly higher, but there will be a great saving in watering, and the chances given to plants to strike root and bring them earlier into bearing will amply repay this. Even in bearing fields where this slab occurs, it would be well to have it broken

up a little and allow the roots to find their own water.

"It would be interesting to hear of results of a few experiments, and also to have the views of some of the veteran planters of the Eastern Province on the subject."

With regard to the cost, I can only give particulars of this in connection with experimental work with rubber, &c., as follows. It will, however, be quite easy and inexpensive for coco-nut and other planters to carry out experiments and work out the cost on their own account, so as to ascertain all the pros and cons, including the cost, of "Farming with Dynamite."

On the Morakelle Estate, in the Kelani Valley, Ceylon, a field of three-year-old rubber adjoining the railway having been selected as most suitable for the experiments, holes were drilled to a depth of 2 ft. 9 in., and single charges of dynamite inserted at distances of 20 ft. × 10 ft. No earth was thrown up by the explosion, but the soil was cracked and loosened within a radius of 5 to 6 ft. of each hole, and on one of the holes being subsequently opened, a considerable cavity was found where the charge had been inserted.

Another experiment carried out, also in Ceylon, to test the relative cost of cultivation carried on by means of dynamite compared with coolie labour, resulted in favour of the explosive, which was estimated to cost on the

average, Rs.10 (13s. 4d.) an acre. This is a point to note in face of the present tendency of the demand for cheap labour in the Tropics to considerably outstrip the supply.

Work carried out on hard, cabooky ground planted with rubber and tea, with 100 holes drilled to the acre (about 21 × 21 ft.), including the preparation of the charges and firing of same, two coolies being employed to do the work, costs as follows. At a very conservative estimate it is reckoned that two coolies could put down at least 175 holes a day working seven hours a day. Such labour at 35 cents each man a day (100 cents = rupee or 1s. 4d.) equals 70 cents. Two other coolies with more experience for preparing the charge, charging the hole and firing, at say, 50 cents each a day, would bring the total cost of four coolies to R.1.70 per day; so that the actual cost would work out at 1 cent, *i.e.*, the hundredth part of a rupee or 1s. 4d., per hole. Coolie labour, it is claimed, cannot be compared with the use of dynamite for such work, since the coolie can only make spade holes of a certain depth and circumference and there it ended so far as effectiveness was concerned, whilst dynamite broke up the subsoil and hard pan, and created a cavity which was both a hole and a reservoir for holding water, at the same time permitting the moisture in the substratum to come through to the roots of the trees during periods of drought, which was in

itself a decided advantage. Again, holes blasted with dynamite remained open for a considerable period, whereas those made by coolie labour, once planted over, and packed tight by the filling-in process, resembled the surrounding soil in its hard primeval state. As for the cost against coolie labour, the use of dynamite in the manner advised served to prove that a greater area could be covered by four coolies using dynamite in the quantities recommended, than by treble that number of coolies with ordinary hand labour. In removing or reducing ant heaps, smashing boulders or blasting tree stumps, dynamite as against coolie labour was altogether more economical. (See *Ceylon Observer* and *Times of Ceylon.*) This has been fully demonstrated on two estates. By the help of dynamite ant heaps were destroyed at a cost of about 15 cents to 25 cents. a heap, whilst by other existing methods it would have cost about 150 cents (R.1.50, or 2s.).

Critics of the use of explosives in agricultural pursuits do not always seem to understand the main advantages of aerating and breaking up the subsoil by means of this modern adjunct to agricultural aids. One of these advantages, by no means the least and perhaps the greatest, is to overcome the serious disadvantages of coolie labour, with its lack of physical energy and enduring strength; in such cases the use of explosives is most welcome, as the

mere scratching over the surface of the soil causes a hard-pan subsoil to form which is unfavourable, if not actually inimical, to the success of any estate, be it tea, sugar, fibres, or anything else. Owing to these reasons the reports published in the East, both India and Ceylon, speak well of the results of using dynamite—and why? It is because investigations after its use have shown the drainage in the soil to be improved by the breaking up of the hard-pan stratum to such an extent that tea planted on abandoned land after dynamiting is said to do better than on land not so treated.

Coming to the matter of cost, a query often raised, and one that cannot be overlooked, the following particulars appeared in the Ceylon press. A case containing 200 cartridges, $\frac{7}{8}$ in. in diameter, cost Rs. 24 (32s.), or 12 cents each; fuse about 1 cent a foot, there being 24 ft. to a coil; of this you use, at the most, 2 ft. to a hole = 2 cents plus half a cartridge = 6 cents, one detonator 2 cents, making 10 cents (or just under 1½d.) in all per hole. Two coolies, as already shown, can put down 25 holes per hour, or 175 holes in a working day of seven hours. Labour cost for each coolie 35 cents, making 70 cents for the two coolies; then add two other coolies who are expert in making primers, charging holes and firing same at 50 cents each per day = R. 1, bringing the total cost for labour up to R. 1.70 per day, or practically 1 cent per

hole for the 175 holes. The total cost, in Ceylon at any rate, of dynamite, detonators, fuse and labour is thus 11 cents per hole; can the cost of coolie labour compare with this?

In Trinidad, B.W.I., dynamite, in the shape of half a cartridge in each hole, was used experimentally for planting coco-nuts and improving cane lands. Unfortunately I have seen no particulars as to the results, but take it that they were satisfactory, as last September (1913) the Agricultural Society in Trinidad passed the following resolution: "In view of the undoubted benefit conferred on agriculture in the different countries where they have been used for subsoil blasting, the Agricultural Society trusts that the Government will offer and encourage every facility for the importation, storage and use, under competent supervision, of dynamite cartridges." [1]

The above resolution was, I believe, the outcome of the following experiments: A sugar cane field of first year's ratoons was dynamited, one-third cartridges being exploded in holes 18 in. deep and 8 ft. apart. In a banana field half cartridges were used placed 10 × 10 ft., and 2 ft. 6 in. deep. A field was prepared for the planting of coco-nuts by exploding full cartridges (weighing ½ lb. each) in holes 3 ft. deep at 25 × 25 ft. apart. On

[1] See *West India Committee Circular* of October 7, 1913.

another field, intended for the cultivation of ground provisions (vegetables), one-third cartridges were again used, and at a depth of 18 in., in holes 8 x 8 ft. apart. The soil in which all these experiments were conducted was a deep sandy loam, and many members of the Trinidad Agricultural Society were present. That the results were satisfactory is shown, I take it, by the subsequent resolution passed, calling upon the Government to encourage and facilitate the use of this new aid in modern agriculture, once it was shown that those storing and handling same understood the work, and were capable of preventing the explosions from taking place at inconvenient times and in the wrong place. Even were it possible to do so (which it would not be with the cartridges supplied, that is if they are used singly), planters must not expect to see the large tree stumps blown out clear of the ground, for sufficient resistance is not offered by the soil to enable this to be done. The explosive rather is apt to expend its force in tearing a large hole in the ground, at the same time loosening the stump, removing the earth around it and forcing it out into the air. Experiments have shown that the best way to clear land of big stumps and roots is by the intelligent use of saw, axe and stump extractor, as well as of dynamite. First trim off the top of the tree, if you wish—but this is not necessary—then put in a charge or half a charge, according to the

size of the stump so as to split the wood, break up the roots and loosen the stump generally. Then comes the process of dragging out the stump and roots by means of a monkey jack, or stump-extractor, with a saw and axe to assist, if needed, in removing the shattered wood. When stumps might perhaps be blown out clear of the ground would be with coco-nut trees, should root disease, pests or other causes render it necessary to remove them. In such cases the network of fine roots would not be so able to withstand the force of the explosion. As mentioned elsewhere, the use of explosives in cases of disease has a double advantage; it removes the stump and helps to kill the life, animal as well as vegetable, that is causing the trouble. Whilst on the subject of stumping, when clearing the land for planting, and at other times, planters would do well to bear in mind that the demand for wood pulp is almost as insatiable as that for copra and coco-nut oil. In certain cases, therefore, it might pay to lay down the apparatus necessary to make wood pulp or cellulose. An issue of *Tropical Life* (January, 1913) also discusses at some length the possibilities of utilizing timber from cleared lands, as well as coco-nut trunks, leaves, refuse, &c., for manufacturing suction gas to supply motive power on the estate either direct or, what perhaps would be best, to drive a dynamo, utilizing the electric power thus generated for driving the machinery. The article mentioned

shows, as far as the space available allows, how this can be done.

In conclusion, I hope to see further reports on the matter, not only over coco-nuts, but in connection with rubber and tea planting and tropical agriculture generally. Meanwhile there is no doubt that explosives have not only come to stay as a necessary auxiliary to modern agricultural science, but their use will extend on all sides until they occupy a prominent and permanent position therein.

NOTES ON THE EXTRACTION OF OIL.

COCO-NUTS, SOYA-BEANS, AND GROUND-NUTS.

ON page 79 of the *Philippine Journal of Science* for January, 1906, Mr. Walker gives the following analyses based on 1,000 nuts, of which 500 were sun-dried and 500 grill-dried. These nuts were taken from a pile of 1,000 each, seashore and inland nuts, after they had been lying for a month to dry, and the resultant weight of each 500 was finally multiplied by two to give approximately the weight of the whole, when it worked out as under. Although already printed in the Manure section, we repeat this table to show the oil and water content of copra in the Philippines or elsewhere, which we can reasonably reckon on as having been carefully and adequately dried.

Taking the nuts first, their weights and proportions worked out as follows :—

	Seashore Nuts		Inland Nuts	
	Kilos.	Per cent.	Kilos.	Per cent.
1. Weight of 1,000 nuts ...	2,368	100·0	2,285	100·0
2. " " husks only ...	897	38·0	703	30·8
3. " " nuts, minus husks	1,466	62·0	1,582	69·2
4. " " meat and shell only	929	—	979	—
5. " " milk	537	22·7	603	26·4
6. " " shell (dry) ...	282	11·9	291	12·7
7. " " meat	647	27·4	688	30·1

It will thus be seen that No. 1 = 2 and 3, and No. 3 = 4 and 5, and also 5, 6, 7.

Analyses of the copra showed as follows :—

	Seashore Nuts				Inland Nuts			
	Sun-dried		Grill-dried.		Sun-dried.		Grill-dried.	
	Kilos.	Per cent.*	Kilos.	Per cent.*	Kilos.	Per cent.*	Kilos.	*
Copra ...	302·1	12·8	330·2	14·0	322·9	14·1	333·0	14·6
Oil ...	182·2	7·7	198·9	8·4	191·1	8·4	189·8	8·3
Moisture in copra ...	—	9·2	—	8·6	—	9·8	—	10·1
Oil in copra	—	60·3	—	60·2	—	59·2	—	57·0

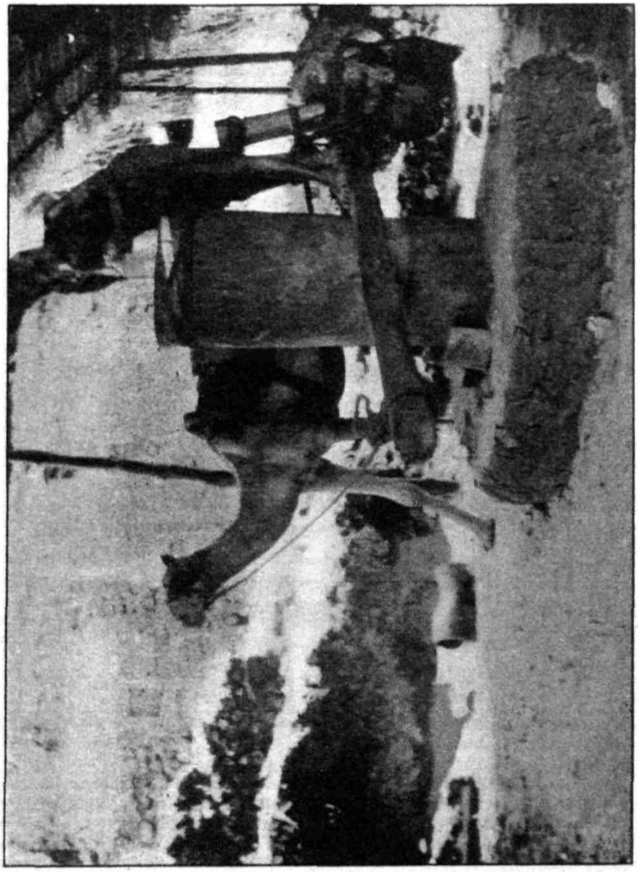
* Per cent., *i.e.*, of total weight of nut in husk.

Roughly speaking, the meat taken from unbroken or undried ripe nuts contains 50 per cent. of moisture, so that if 10 per cent. is left in the copra for shipment, 40 per cent. has to be removed by drying. This means that if the meat of 1,000 nuts weighs 647 kilos, say 650 to facilitate calculations, then 260 kilos, or, roughly, a ¼ ton, of water has to be evaporated out of every 1,000 nuts to be treated. At this rate 1,000,000 nuts would mean the removal of 250 tons of moisture.

Average Copra and Water Contents of Ten Nuts.

Per cent.	Series 1	2	3	4	5	6	7	8	9	10	11
Copra ...	46·5	52·0	51·3	40·7	33·7	50·1	53·3	48·5	50·9	52·2	49·1
Water ...	53·5	48·0	48·7	59·3	66·3	49·9	46·7	51·5	49·1	47·8	50·9

No. 1. Nuts fresh from trees, but fairly ripe, all green husks.
,, 2. Nuts very ripe, dead-brown husks.
,, 3. Nuts stored three months, just beginning to sprout.
,, 4. Nuts stored six months, but which had not sprouted. Here the variation among individual nuts (29·3 to 54·7 of copra and 45·3 to 70·7 of water) was rather greater than had been expected.
,, 5. Nuts not fully ripe, fresh from tree.
,, 6. Nine nuts only, from same tree as No. 5, but fairly ripe.
,, 7. Ten nuts here, from same tree as No. 5, but dead ripe.
,, 8. Ten thoroughly ripe nuts from one tree.
,, 9. ,, ,, ,, ,, ,,
,, 10. Ten nuts from a pile of 1,000 taken from trees near the sea.
,, 11. Ten nuts from a pile of 1,000 from trees about 1,800 ft inland.



A "CHEKKU," OR NATIVE OIL MILL.

Consisting of a mortar with a large pestle, moved by animals, in this case a camel.

Further particulars given by Mr. Walker in connection with these eleven series include :—

AVERAGE PERCENTAGE IN NUT FREE OF HUSK.

Series	1	2	3	4	5	6	7	8	9	10	11
Shell ...	21·2	20·0	21·6	20·0	19·2	19·3	19·4	21·8	19·1	20·1	19·5
Meat ...	40·5	41·7	45·8	46·0	34·4	41·7	43·8	42·8	42·5	42·1	39·8
Oil ...	12·4	13·4	14·5	12·4	7·5	13·6	15·5	13·3	13·8	14·7	12·0
Milk ...	38·3	38·3	31·4	34·0	46·4	39·0	36·8	35·3	38·4	37·8	40·7
Copra ...	18·9	21·7	23·5	19·5	11·5	21·0	23·4	20·4	21·6	22·0	19·7
Copra weighed— grms. ...	286	349	309	245	135	232	242	238	272	354	370
% of oil ...	65	61·4	61·8	65·9	64·5	64·7	66·0	64·0	*	65·0	61·9
% of pulp	35	38·6	38·2	34·1	35·5	35·3	34·0	36·0	*	35·0	38·1

* Copra destroyed by accident.

Extraction is sometimes undertaken for the production of oil only, sometimes for the manufacture of oil and a feeding cake, and occasionally for the production of oil and a fertilizing material.

If a cattle cake is required then the oil is perhaps more safely obtained by expression, but if the residue is only required as a fertilizer, or, as sometimes happens, owing to the absence of a market or any local demand for the cake, is entirely a waste product, then more satisfactory results are obtained by extraction by means of a solvent.

The difference between the results of the two methods lies in the yield of oil obtained. The expression process obtains only a proportion of the oil, the balance remaining behind in the cake to the benefit of the cattle, and in most countries the laws governing the sale of such cattle food demand a certain minimum percentage of oil.

In the case of the solvent extraction process practically the whole of the oil is recovered and consequently the cake is, comparatively speaking, free. This is a most desirable feature when the application of the residue is for manurial purposes, because grease or oil in any form acts as a deterrent from absorption of the nitrogenous matters by the soil.

Taking the soya-bean for example, in Manchuria, where this bean is most largely cultivated, the oil is expressed in a rude form of plant, so that the yield is poor, and as the residue is shipped to Japan for use in the paddy fields, not only a needless, but even a harmful, waste of oil results, since its presence in the cake used as a fertilizer in Japan prevents the full benefits of the plant food from going into the soil.

Now if central extraction factories were established the percentage of oil extracted in Manchuria would be greatly increased, and the residue would be improved as a fertilizer to a very important degree.

Those interested in the manufacture of coconut oil and its by-products will note that we have said nothing about the conversion of the oil into soap, or about the splitting up of the oil into fatty acids (oleine and stearine) in order to produce candles from the latter, with glycerine as a by-product. This does not come within the scope of our book, but we shall be pleased to discuss the matter with anyone wishing to follow it up.

The following statistics of the world-production of oil in 1897 were included in an article in *Der Pflanzer* of September, 1911. These figures were compiled fourteen years ago, but what the quantity will be this year of grace (1913) we are not capable of estimating. We include them, however, to give our readers some idea of the comparative output of the various centres, and the proportion exported :—

Copra oil.	In million marks. Production.	Export.
Ceylon ...	60	36
India ...	30	5
Java—Sumatra ...	21¾	18·3
Straits Settlements	—	14
Philippine Isles ...	26¼	15
East Indies ...	8¾	—
Pacific Ocean Isles	21¾	3·7
East Africa ...	9¾	2·2
South America ...	43	7
Central ,, ...	30	7
Various... ...	48¾	—
Total world production	300[1]	108·2

[1] Equal to about 4,000 million nuts.

A short, handy way of estimating the output or possible output of oil is to go by the number of trees about, that is of the full-bearing trees. It requires, Ferguson's Handbook tells us (p. 8), about forty full-grown nuts, or a year's crop from an average tree, to make one gallon of oil, and twelve and a half gallons of oil, or 500 nuts, go to a cwt. of oil, and rather less than fifteen gallons or about 600 nuts, to make a picul. One planter in 1887 claimed to get three gallons of oil, at 9 lb. 3 oz. to the gallon, from 45 lb. copra passed through "chekkus,"

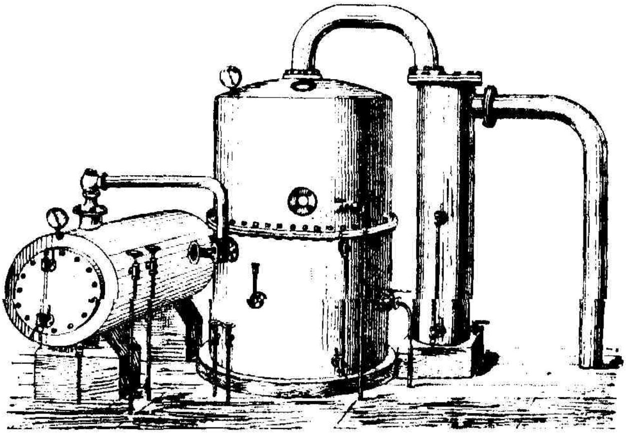
or native mills, of which he worked many for years.

With three nuts to 1 lb. copra, this means 1·35 nuts, or the same forty-five nuts to 1 gallon of oil, and is calculated to be 61·8 per cent. of oil on the total weight of the copra. "Therefore, from experiments made," reports Herbert S. Walker in the Philippine *Journal of Science*, "to obtain the largest yield of copra and oil, only thoroughly ripe nuts, the husks of which have begun to turn brown, should be used, and it is often advisable to allow the latter to stand in a dry place for a few weeks before they are opened. On the other hand, the nuts should not be stored too long, for in about three months the embryo begins to grow, and, even before that time, those nuts which may have been cracked or bruised in gathering, have a tendency to become rancid."

Coming to the question of deodorizing and purifying coco-nut and other vegetable oils effectively, and at the same time as economically as possible, brings us to the firm of Edouard Bataille of Paris (11, Avenue Malakoff), whose vacuum plants for purifying vegetable oils are well known to manufacturers both in Europe and the Tropics. Manufacturers of margarine and others who need large quantities of vegetable oil and butter as their raw material, are nowadays forced to neutralize and deodorize the produce as thoroughly and rapidly as possible before they can use the oil. It was the dis-

covery as to how this could be done that gave the tremendous impetus to the edible coco-nut butter trade at the beginning of this century, and led to the introduction of the necessary machinery and apparatus to free the oil from acidity and other undesirable tastes or properties.

To do this satisfactorily the oil must first



BATAILLE'S OIL PURIFYING VACUUM PLANT.

be treated with soda, and afterwards washed with water to remove any traces of its soda treatment.

The deodorization and general purification of the oil is obtained by violently agitating the oil *in vacuo* through the introduction of steam jets. This method has been adopted by the leading firms in the trades mentioned, *i.e.*, by

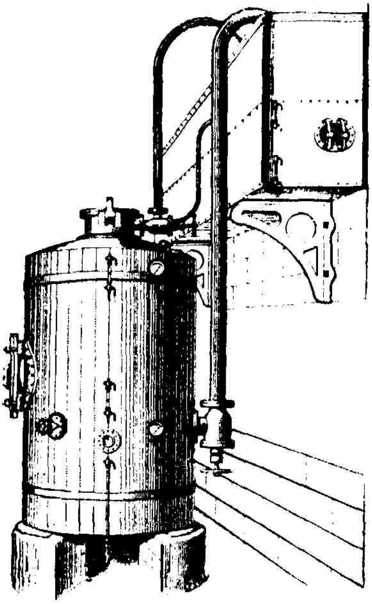
makers of vegetable butter and margarine, as well as those who simply refine the oil for others to use.

The Bataille plant is one of the best, if not actually the best, apparatus for the work. Oil-makers agree that by its use every trace of taste or smell is removed from the oil, whether coco-nut or otherwise. Recognizing this has caused the Bataille machines to be generally adopted on the Continent and elsewhere, especially as, whilst being reliable and effective, they are at the same time simple in construction, economical to buy and to work, and the wearing parts are cheaply, quickly, and easily replaced. The machines are so simple that the services of an engineer or chemist can be dispensed with, although large establishments employing such assistants would of course find their services of use at times.

The apparatus, as shown in the preceding illustration, consists of two vessels, made of tinned sheet-iron, so shaped as to allow the oil inside to be violently stirred up and agitated by means of jets of steam, produced from the water boiled *in vacuo*, and therefore at a low temperature, avoiding any taste of cooking. From this first portion of the apparatus, the steam passes through into the condenser, still under vacuum, and the oil becomes completely separated from the water and steam.

Coco-nut, palm-kernel, soya-bean, cotton-

seed, ground-nut, sesame, poppy, linseed, rape, sunflower and other oils can all be treated in this way, and all trace of scent or taste of the mother nut or seed completely eliminated.



INSTALLATION FOR THE EXTRACTION OF OIL BY THE SOLVENT PROCESS. BATAILLE'S SINGLE SIMPLEX EXTRACTOR.

(1) The extractor with the necessary distilling apparatus.
(2) The condenser and reservoir.

So completely and effectively does the apparatus complete its task that, in most cases, the free fatty acids are also removed, and therefore a perfectly clear oil obtained by

the one process. When this is possible, the previous treatment with soda is avoided. This is often the case with coco-nut oil if treated in the Tropics immediately on its extraction from the meat.

To extract the oil the best known apparatus —one, too, that is perfectly safe and needing no mechanical parts and no pump—is the Single Simplex Extractor, introduced twenty years ago by M. Bataille, whose firm has installed this system in the works of the various firms treating nut and seed oils in England, France, Germany and elsewhere with the utmost success. The Bataille solvent extraction apparatus is especially suitable for shipment to the Tropics, as it consists of only two vessels, as shown in the drawing on the preceding page, viz. :—

(1) The extractor with the necessary distilling apparatus.

(2) The condenser and solvent tank (reservoir).

In the upper portion of No. 1 is the extractor; here the solvent passes through the raw material and dissolves the oil. This solution then passes to the lower part, where the solvent is parted by distillation from the oil, the distilled solvent going back to the condenser No. 2. The oil remains in the lower part of No. 1 and is then purified by steam jets, taking away any trace of solvents, and, at the same time, refining the oil. In the

upper portion of No. 1 chamber, the raw material is meanwhile treated with steam, to recover the solvent, and when removed from the extractor, comes out perfectly dry and deodorized. The upper portion of No. 2 is the condenser for the steam and solvents, and the lower part is the solvent tank, where the condensed solvent is parted from the water by specific gravity. The plant is most carefully constructed to do the work required of it, and this enables it to last for years and years.

One of the best known extraction plants is that manufactured by Messrs. Scott and Company, of London, W.C. For treatment by this method the copra, soya-beans, or ground-nuts, which should first be lightly crushed (with the beans this need only be done sufficiently to break the husk), are then elevated into one or other of the extractors and there subjected to a combined liquid and vapour bath of benzine or similar solvent. This quickly removes the oil from the seed, though several changes of benzine are usually necessary for the purpose.

The oil and benzine mixture is pumped into a patent tubular still which recovers the benzine by distillation and condensation, and leaves the oil ready for a simple washing preparatory to packing for sale.

The seed remaining in the extractor is meanwhile treated with steam to recover the benzine, with which the residue has naturally become

saturated. This benzine is then treated in the condensers and automatically delivered, after being condensed, to a water separator and thence to the main store tank. The dry residue is now removed from the extractor, which is immediately ready for a fresh charge.

The same process is applicable to the extraction of copra or ground-nut oil, and, in fact, any oil-bearing substance. It sometimes requires modification to render it suitable for special materials, but we understand its application in one form or another covers a very wide field of industry.

Efficient arrangements are provided for preventing accumulations of vapour at any point, and none of the Scott plants have yet suffered any trouble through fire or explosion.

ALCOHOL FROM COCO-NUT PALMS.

No producing centre, not even Ceylon, has made so minute and exhaustive a study, during the last few years, of the coco-nut palm and its possibilities as has the Bureau of Science in the Philippine Islands. Whilst Ferguson's "Coco-nut Planter's Manual" should be studied and kept close at hand by everyone interested in the coco-nut and everything to do with its products, and by-products, the *Philippine Journal of Science*, during the last six or seven years, has added original and up-to-date information, the like of which we have neither seen nor heard of from any other source. Prominent among these investigations have been those of Dr. H. D. Gibbs, on "The Alcohol Industry of the Philippine Isles." According to this authority, the Philippine Customs show that the following were the exports of copra and oil from these islands since 1906. The sudden stoppage in the shipment of oil in 1910 was due to a fire having destroyed the factory.

	Copra. Tons of 1,000 kos.	Oil. Tons of 1,000 kos.
1906	66,158 ...	—
1907	49,082 ...	—
1908	76,420 ...	2,915
1909	105,565 ...	1,484
1910	116,375 ...	nil.

We have not the exports for 1911, but according to official returns the total value of the copra shipped from the Port of Zamboanga in 1911 was P 568,806 (say £56,806) against £54,122 in 1910.

Besides the above, large numbers of the palms are utilized exclusively for the sap, from which is made a distilled drink similar to the arrack of India and elsewhere.[1] This drink is different to *tuba* or toddy, which must be consumed within twenty-four hours at the most. The sap is obtained by cutting the top of a flower-spathe "before it has any fruit, and thence the liquor which was to feed its fruit runs into the calabash hung to receive it. This will continue almost as long as the fruit would have been growing, and then it dries away.[2] The tree has usually three fruitful branches, which, if all are tapped, then no fruit is obtained that year; but if only one or two are tapped, the other will bear fruit all the while." Thus reports Dampier as far back as 1686, and the system employed by the natives is much the same to-day. Quoting Cleghorn, in Sir George Watt's "Economic Products of India," we learn that the method employed in Madras is as follows: "When the spathe

[1] See June (1911) issue of the *Journal of Science*, Manila, for Dr. Gibbs' report on the production of palm wine and alcohol from the coco-nut.

[2] See note on page 542, and also 544 regarding the time this should take.

TAPPING FOR PALM WINE.

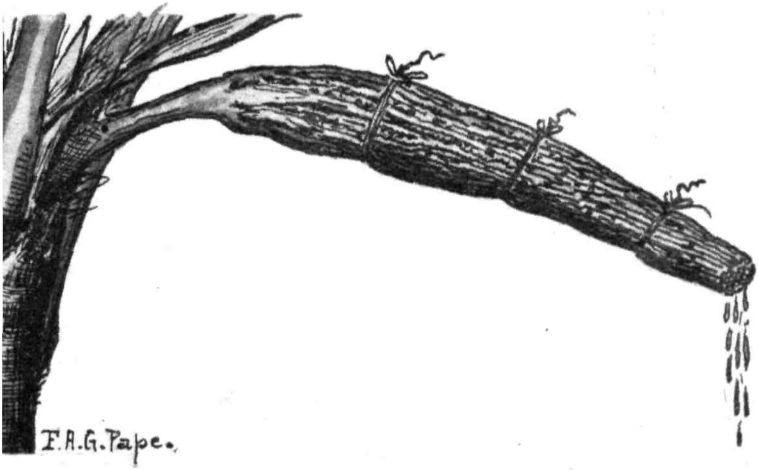
(Note the chatty on the right suspended from the flower spathe to catch the sap.)

is a month old, the flower-bud is considered sufficiently juicy to yield a fair return. When ready for tapping, it (the spathe) is 2 ft. long and 3 in. thick. It is tightly bound with strips of young leaves to prevent expansion, and the point is cut off transversely to the extent of 1 in. The toddy-drawer then gently hammers the cut end of the spathe to crush the flowers exposed, and to determine the sap to the wounded part, that the juice may flow freely. The stump is then bound up with a broad strip of fibre. This process is repeated, morning and evening, for a number of days, a thin layer being shaved off on each occasion, and the spathe at the same time trained to bend downwards. The time required for this initiatory process varies from five to fifteen days in different places. The time when the spathe is ready to yield toddy is correctly ascertained by the chattering of birds, the crowding of insects, the dropping of juice, and other signs unmistakable to the toddy-drawer. When the juice begins to flow, the hammering is discontinued. A single spathe will continue to yield toddy for about a month, during which time the collector mounts the tree twice a day, and empties the receptacle."

Molisch in Java, reports Gibbs, gained the best results by following the Javanese method, and binding the spathe as illustrated.

In the morning and evening, a thin slice

about 5 cm. long was cut from the end, and after four or five days the sap began to flow. In the Philippines, to facilitate the gathering of the toddy, bamboo poles are often, and in fact generally, attached from tree-top to tree-top, forming bridges upon which the collector can pass without descending to the



FLOWER-SPATHE BEING TAPPED FOR PALM WINE.

ground, until his receptacle is full. As the coco-nut palm blossoms throughout the year, the season for collection is continuous. As to yield, Cleghorn states that 40 trees yield about 12 Madras measures ($1\frac{1}{2}$ to 2 galls. or 5·68 to 7·57 litres) daily, say 7 in the morning and 5 in the evening. Schortt (in Watt's "Economic Plants of India") says that the yield will vary according to the locality of

the tree and the age of the spathe, and that 3 or 4 quarts (2·84 to 3·79 litres) is the average quantity obtained in twenty-four hours for a fortnight or three weeks. In India 35 to 64 imperial gallons are obtained per tree; other returns give 10·5 galls. or 47·7 litres a month. In the Philippines, Gibbs says, "the flow (in each case measured from one inflorescence) from twelve different trees during the night, practically twelve hours, gave an average of 472 cubic centimetres. . . . A tree will grow about ten fruit stalks annually, and each one will run sap for about two months. Trees in good condition, grown on good soil, produce about 400 litres of sap annually, and are in their prime when forty years old. Young trees often produce less than 300 litres. Improper tapping and other causes can reduce these yields. The average yield of 5,785 trees attached to seven distilleries gave an average daily production of 65 litres."

Gibbs gives the following analysis of the sap:—

(1) An average tree in its prime, in the fresh sap of which no chemical change has taken place, will probably give about the following results. Results stated as grammes per 100 c.c.

Density	1·0700
Total solids	17·5
Acidity	Trace
Ash	0·40
Sucrose	16·5
Invert sugar...	Trace
Undetermined nitrogenous compounds ...	0·60

(2) Sample of toddy collected by a native in the usual manner, and representing a composite from a number of trees, was preserved with a large excess of formalin. The collections were made at 7 a.m. from the bamboo joints which had been filled by the night's flow, and the sample was preserved three hours later. On analysis this gave the following figures, expressed as grammes per 100 c.c.:—

Density at $\frac{15^\circ}{15^\circ}$	1·0100
Total solids	3·72
Acidity as acetic	0·68
Alcohol	6·00
Ash	0·41
Sugars.	
Polarization at 30°	0·65
Invert reading	1·02
Sucrose by Clerget per 100 grammes ...	0·29
Invert grammes	1·95

The sap ferments rapidly and becomes intoxicating, giving as much as 11·9 per cent. proof spirit, equivalent to 5·86 per cent. alcohol by weight. One hundred gallons of toddy equals 25 gallons of arrack, by distillation estimated to be about 24 per cent. in alcoholic strength.[1]

[1] Unfortunately, we cannot go fully into the question of distillation here, but must refer our readers to such works as Watt's "Economic Products of India" and Mr. Gibbs' very full report in the *Philippine Journal of Science*. There will be found details as to selling price and cost of production. We only introduce the particulars already given, as well as those *re* sugar, &c., to give planters some idea of what can be done with the products of the palms in one form or another.

Sugar made from the sap is, apparently, unknown in the Philippines, but is well known among the natives of Ceylon, India and Guam (an island in the South Seas, belonging to the United States). The sugar, as with cane-juice, is obtained by boiling, and in India, ten to twelve seers of sap yield one of jaggery, or gùr, a dark brown, semi-viscid mass, which, if granulated, would lose heavily in weight, for it can be refined according to European principles.

Discussing the question of obtaining sugar from the coco-nut, nipa, and other palms, we learn from Dr. H. D. Gibbs that there is a possible, not to say a probable chance of the business of making sugar in the Philippine Islands becoming a profitable one. Discussing the nipa first, we are told that the advantages of its product over those of cane lie in there being a practically inexhaustible supply of nipa trees located all over the Archipelago. Another feature is that, since the sugar would be produced from sap, the crushers in the ordinary sugar mill, which form one of the heaviest items of expense in the mechanical line, would be unnecessary. Another considerable item is that once planted, the nipa takes care of itself, that it requires no cultivation, and that its product may go on for a century. Trees which have been producing for half that time, viz., fifty years, are already on record among unimpeachable authorities. The method of

extracting the sap is very simple, consisting of the native puncturing each tree, and drawing off the liquid in bamboo measures, day by day, this operation lasting for about an average of seventy days annually with each tree. Of course, the process of extraction can be carried on practically all the year, because different trees may be used in the same tract, thus keeping up the business all the year round.

The figures from the yield of one hectare, by a series of measurements, show that from 2,000 nipa trees sufficient sap may be drawn to produce 10,428 kilos of sugar (say 10½ tons) of 96 per cent. polarization. At 16 centavos per kilo, a fair average value, this would bring a gross income of 1,668·48 pesos, from which the expenses must naturally be deducted.

Reference has been made principally to the nipa trees, but in addition there are also three other varieties of trees, the coco-nut, buri, and sugar palms, all of which produce sap suitable for sugar. The advantage of the transportation of sap over that of the heavy sugar-cane to the mills is, of course, plainly obvious, since the labourer merely steps from his banca to the shore, extracts the sap, pours his bamboo measures into some larger receptacle in the banca, and paddles away to the mills, one man being all that is necessary for the operation, and the building of railroads, as needed in the case of sugar-cane, being unnecessary for transportation purposes.

It has been estimated by Dr. Gibbs and his assistants that an area of from 750 to 1,000 hectares of nipa trees would be sufficient to keep a 500-ton sugar mill running for 180 days.

In addition to the sugar industry, there is also the production of alcohol, which can be made from the sap of the nipa tree in quantities sufficient to supply the entire China coast, besides what is needed for local consumption. Last year over 9,000,000 litres of alcohol were made from 90,000,000 litres of sap, and this is merely a small fraction of what might be done.

In addition to taking sap from the nipa trees for alcohol, coco-nut tree sap is largely used, and the scientists have demonstrated that the production of the coco-nut trees may be increased by over 112 per cent. by intelligent handling.

Experiments made with regard to the yield of sap from 100 coco-nut trees for a period of thirty-one days, with two collections per day, showed that the average daily production of sap per tree was approximately 1·4 litres each.

Whilst this is extremely interesting to hear of, we would say that such large withdrawals of sap must tell heavily upon the palms, and by reducing their vigour decrease both the size and quantity of the nuts. In fact, such trees would, we feel, be useless for copra-production—at least, when being systematically tapped as described. All the same we include

these details, as it may still pay some estates to make alcohol or sugar instead of copra.

Vinegar, of course, is but one step further. When well made it is reported to be of good strength and colour, of the highest keeping qualities, and of unrivalled flavour. According to Gibbs, quoting Lyon, "its excellence is so pronounced that, upon its merits, it would readily find sale in the world's market; so that the production of vinegar will probably prove a more profitable industry than even toddy-making in the future."[1] Analyses of the crudely made article show potential possibilities, adds Gibbs, of producing good vinegar from the sap of the coco-nut palm. We believe excellent vinegar could also be made from the milk of the coco-nuts as well. As is shown by the analyses on p. 526, the milk almost rivals the meat itself in weight.

Mr. O. W. Barrett writes us as follows on the question of the Philippine coco-nut industry, and his report can as well be introduced here as elsewhere :—

"With 33,000,000 trees[2] reported to exist to-day in the Philippines, with a harvest of about one billion nuts (which is about one-half

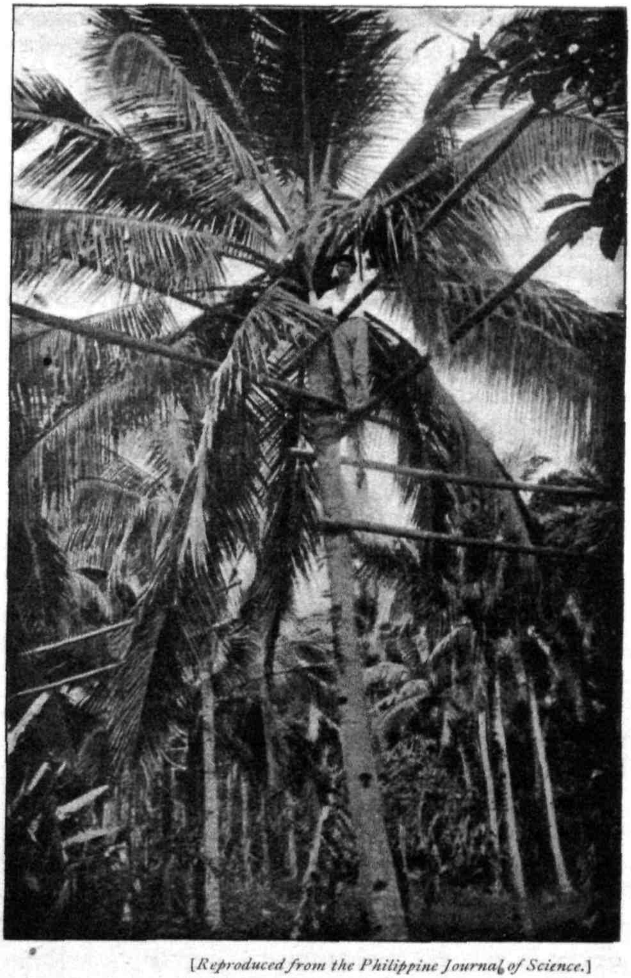
[1] We would like to state that we found this remark of Lyon's at the very last moment, and quoted it to confirm our own ideas on the subject. *See also* p. 216 and elsewhere in "The Fermentation of Cacao," price 10s. net, *Tropical Life* Publishing Dept.

[2] More recent statistics speak of 50,000,000 trees in the Philippines against 60,000,000 in Ceylon.

what the normal yield should be), and with only about 4,500 nuts required for one ton of copra, it must seem strange to the outsider that only 125,000 tons of copra are exported instead of the 500,000 tons which should be in evidence. Where, then, is the 75 per cent. loss?

"To begin with, the coco-nut probably suffers more from mistreatment in the Philippines than in any other country in the world, and this serves to reduce the normal output by about 50 per cent.; again, in many districts very little copra is made because of the great demand for 'tuba,' or toddy, and between the nuts consumed as food locally and the vast quantity of tuba drunk, either locally or in the immediate neighbourhood of the plantations, the remaining 25 per cent. is accounted for. During the fiscal year 1909-10, it is estimated that about 175,000,000 litres of tuba were consumed in the Archipelago. There was also produced in the same fiscal year about 7,000,000 litres of coco-nut oil (1,540,000 imperial gallons)—quite enough to arouse the envy of the European oil manufacturers.

"However, coco-nut planters are trying to break away from the old 'costumbres,' which have been responsible for much of the bad management in the past, and I have no doubt that a few years more will see a great change in the copra business in the Archipelago. In fact, many of the new plantations are



[*Reproduced from the Philippine Journal of Science.*]

TAPPING COCO-NUTS IN THE PHILIPPINES FOR THEIR SAP.

(Note the bamboo bridges fastened from tree to tree.)

actually considering the question of catch-crops, cover-crops, and proper distances—quite a new departure.

"The question of drying the copra is one that will give considerable trouble for some years to come, but the 'ice has been broken,' and at least one modern dryer has been ordered and three or four types of 'home-made' apparatus are about to be tried out. Already the Philippines are producing one-third of the copra of the world, even with the plantations running at half-speed, so to speak, and the area suitable for coco-nut planting is hardly more than half planted up. The sad fact about Philippine copra is that about two-thirds of it is made by the 'tapáhan' method, which means that it is not only badly smoked but irregularly dried, so that during transit (or before) a large percentage of the material rots. Hence the Philippines have the credit of producing the most and, heretofore, the worst copra in the world. It is said, however, that the product from Cochin- and Indo-China is about as bad. In the Visayas, especially in the Island of Cebú, the copra is for the most part dried in the sun, and although this sort of article necessarily is more or less dirty and mixed with sand, it is *whiter*—at least, until it becomes covered with blue, green, and yellow mould. One large artificial dryer in the Islands (which it seems is seldom used) produces copra which will endure storage

for at least eight months, even in a badly ventilated go-down.

"I have seen nuts wasted more recklessly in Zambesia, and brush growing as high between the rows at Trinidad, but I have never seen tree-vigour so ruthlessly weakened as here in the Philippines. Probably a part of this trouble can be charged to the old 'cacique' system, introduced by the Spaniards. By this system the owner, or rather the boss, of the plantations of the district, imposed certain rules and customs upon the people living upon the estates in his neighbourhood, and since he almost always received a vast income and therefore did not care much for the details, the down-trodden labourers and would-be small planters were not particularly interested in the ways and means by which the crops were turned into the pockets of the aforesaid cacique. Some of the 'Datos' of Mindanao still rejoice in this system, but their power has been broken in the last few years, especially in the coast areas.

"Another cause for the absurd close planting of coco-nuts here is the custom of leasing and selling plantations by the *number of trees* rather than by the area. This brings about a ridiculous state of affairs; for instance, when the yield of the plantation begins to fall off seriously, and the trees (frequently only 15 ft. or 20 ft. apart) commence robbing each other of light and food, the shrewd proprietor,

contemplating the sale or rental of his grove, puts out a *new plantation under the old*, setting the young palms, which, of course, can grow only *very* slowly, between the rows of the almost worthless old trees. Even if such a planter can be made to admit that he would receive twice the income by cutting out half of his trees, he would not dare to run against public criticism by so doing—which is another instance of the deplorable power of 'costumbre.'

"The planters are slowly learning their lesson that coco-nuts will grow and do well at long distances from the sea coast and at a considerable elevation; neither salt water nor salty winds are requisite any longer. The world's best coco-nut district, Laguna Province in Luzon Island, is situated some 20 miles from the ocean and protected by mountains besides.

"A new feature of the coco-nut business has attracted some attention recently in the Philippines; the sap from the flower-spathes contains about 16 per cent. sucrose, and it only remains for the organic chemists to devise some practical method of preventing premature fermentation in the tuba, in order to start new sugar and alcohol industries here. This tuba can be purchased at 1⅕ centavos per litre, or about 3d. for 10 litres (2 imperial gallons). One tree will yield 1⅓ litres of tuba per day; roughly speaking, then, ten trees will give 1 kilo of sugar per day and

twenty-five trees one ton per year, under (the usually) continuous tapping; at this rate, if all their force were turned into sugar, the 25,000,000 bearing trees would produce 1,000,000 tons of sugar each year, which is one-seventeenth of the world's total production from both cane and beet. Some 20,000 tons of sugar are consumed annually in the tuba. £300,000 practically wasted in swizzle!

"By the way, as already shown, according to experiments conducted by Dr. H. D. Gibbs, of the Bureau of Science, the buri and nipa palms can also be utilized as either alcohol or sugar producers. The buri palms (*Corypha elata*) in the Philippines could easily produce 75,000 tons of sugar per annum; or, if all the trees were tapped at once, about 1,500,000 tons could be thrown on to the market: this is ten times the cane-sugar output of the Islands.

"The nipa palms (*Nipa fruticans*) of the Philippines are now producing some 70,000 to 85,000 litres of tuba per hectare per year, and since this sap contains from 12 to 17 per cent. of sugar, it will be seen that about 3 tons of 96 per cent. sugar could be obtained continuously at very little expense from every acre of the many square miles of nipa swamps in the Philippines. Incidentally, it is shown by Dr. Gibbs that the nipa is one of the cheapest alcohol producers; the raw material for an imperial gallon of 90 per cent. (180

proof) alcohol costs about 5d. to 9d., and with pipe-lines to convey the raw material to an up-to-date distillery, this figure could be reduced by perhaps one-half.

"To come back to coco-nuts again, it is probable that only about 25 million of the 33 or 35 million trees are now in the bearing stage. On account of the advancing prices of copra and the discouraging prices for abacá (Manila hemp), many new groves have sprung up in several districts, especially Laguna, Tayabas, Sorosogon, Albay, and Ambos Camarines. Several American and a few English syndicates are beginning operations on a large scale in Mindanao, Mindoro, and Palawan. The plantations in Mindanao and the Sulu Group will, undoubtedly, be exceedingly profitable if adequate labour can be secured; these Islands are beyond the typhoon belt, and, generally speaking, the soil is very well adapted to coco-nuts. The plantations in Samar and Leyte have suffered considerably from typhoons during the last few years.

"Thus far the Archipelago has been very fortunate in having few serious pests in the coco-nut plantations. Thanks to the earnest efforts of Dr. E. B. Copeland, of the College of Agriculture, an outbreak of 'bud-rot' was promptly checked a few years ago, and the planters are now well informed as to precautionary measures in connection with this

THE PROTECTION OF BUILDING TIMBER AND OTHER WOODWORK.

It will have been gathered from the foregoing pages that timber is an important item for various purposes when forming an estate. Equally important to the planter is the necessity of protecting that timber from the white ant, borer beetle, and sundry other wood-destroying pests peculiar to tropical countries. There can be no question of the wisdom of treating all woodwork, intended to be of a permanent character about the estate, by some means which will ensure a substantial prolongation of its life beyond what could be expected of any wood left to the ordinary course of decay and insect attacks in the Tropics.

Bungalows, coolie lines, fencing posts, &c., are all liable to rapid deterioration and heavy renewal costs, if means are not taken in the first instance to preserve such woodwork. In a set of plantation buildings involving an expenditure of anything up to £1,500, it would be a "penny wise" policy not to make an additional outlay, even up to 10 per cent. of the total cost, for an efficient means of preservation which should ensure the life of ordinary timbers being at least doubled under tropical conditions.

The point, therefore, to consider is, what are the features which render a preservative treatment best adapted for plantation woodwork? The requirements of such a treatment are carefully set out in the following extracts from an article which appeared in *Tropical Life* for September, 1911:—

"It is obvious that there are many cases in the Tropics where timber, whether for railway, building, or fencing purposes, cannot be treated with a process involving the use of special plant; and in such cases an efficient preservative solution applied with brushes or sprayers ensures much longer service in comparison with the life of untreated timber, and amply justifies the cost of material and labour for the purpose. Where the circumstances allow of immersing the timber in the solution, in an open bath, however rough and ready, a higher degree of impregnation is of course obtained with a corresponding advantage in the life of the timber. Moreover, where large quantities of timber are being handled, the immersion method is certainly quicker and more economical.

"The degree of impregnation to be obtained with any preservative solution is not so much dependent on the method of application as on the character of the wood and its condition at the time of treatment. It is obvious that a length of sapwood immersed in an open bath would absorb a greater quantity of solution

than a similar length of heartwood cut from the same tree and treated under pressure, even though the process was carried so far as to injure the fibres. It may fairly be advocated that any timber which is immersed in an open bath sufficiently to enable it to absorb approximately the maximum quantity of solution which it is capable of taking up by capillary attraction, is sufficiently impregnated for all practical purposes, provided, of course, that such timber is seasoned before treatment.

"The requirements of an efficient wood preservative in the Tropics may be summarized as follows:—

"(1) It must absolutely protect the timber from termites and other insects, fungus, and dry rot.

"(2) It must be easy of application, either by immersion, painting, or spraying, so that woodwork *in situ* can be treated where necessary.

"(3) It must be non-corrosive, so as not to affect nails, spikes, or other metal work brought into contact with it.

"(4) It must be economical, and preferably should be prepared in a highly concentrated form, capable of dilution on the spot, to reduce transportation charges to a minimum.

"(5) It must not be, if possible, inflammable; on the contrary, it should be of such a nature as to render the wood more resistive to fire.

"Doubtless there are many preservatives aiming at these requirements at present undergoing exhaustive tests in the Tropics; though up to date, no one method appears to have met with general acceptance in all quarters. We notice, however, that the now fairly well-known Atlas treatment is gaining general favour in India and other termite-infested countries, and appears to fulfil the above-mentioned requirements to a satisfactory degree."

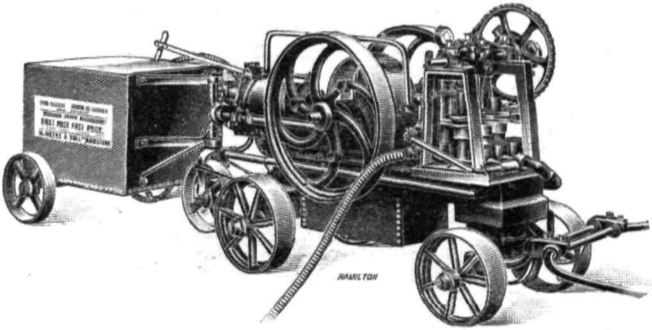
A particular advantage of using a reliable wood preservative is that, by its aid, a poor class of timber, obtained in many cases in the course of clearing an estate, can be rendered equal to more durable timbers for building and fencing purposes. Such timber, however, if not properly seasoned and treated, would be practically valueless except for firewood.

Atlas "A" wood preservative has apparently been proved beyond question to be thoroughly efficient in protecting woodwork from white ants and other destructive organisms, and meets the other requirements enumerated in the above-mentioned article.

MECHANICAL APPLIANCES.

Spraying Machines.

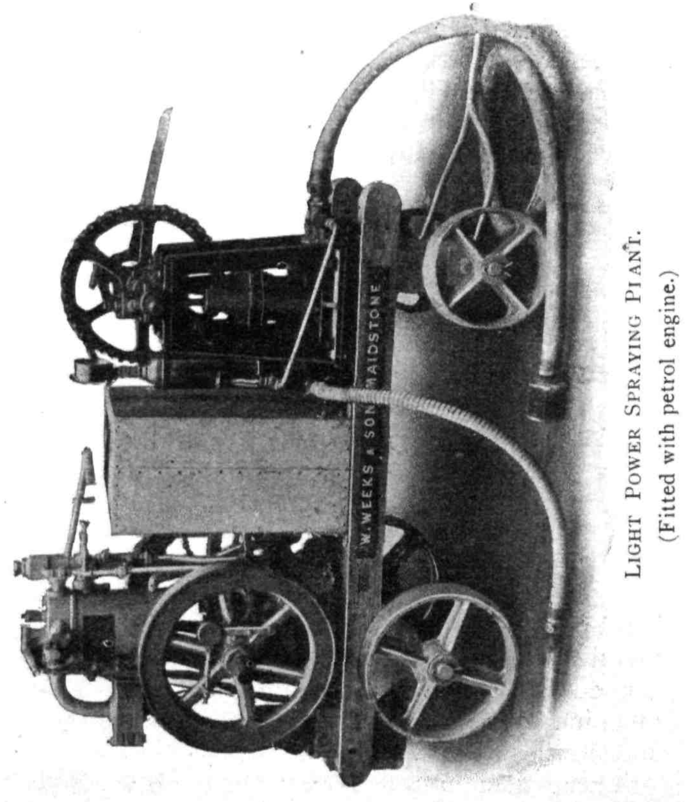
To be able to use insecticides and fungicides, as recommended in this volume, to the best advantage, the planter must provide himself with a substantially constructed apparatus, having a powerful pump capable of producing a fine and effective spray, and ejecting it to a



Messrs. Weeks' Power Spraying Plant
(Fitted with oil engine), for Spraying Coco-nut and other tall palms and trees.

considerable height, viz., right into the crest of the tallest palms.

Messrs. W. Weeks and Son, Ltd., of Maidstone, England, manufacture spraying machinery of all kinds. Their machines have proved themselves to be right in the front



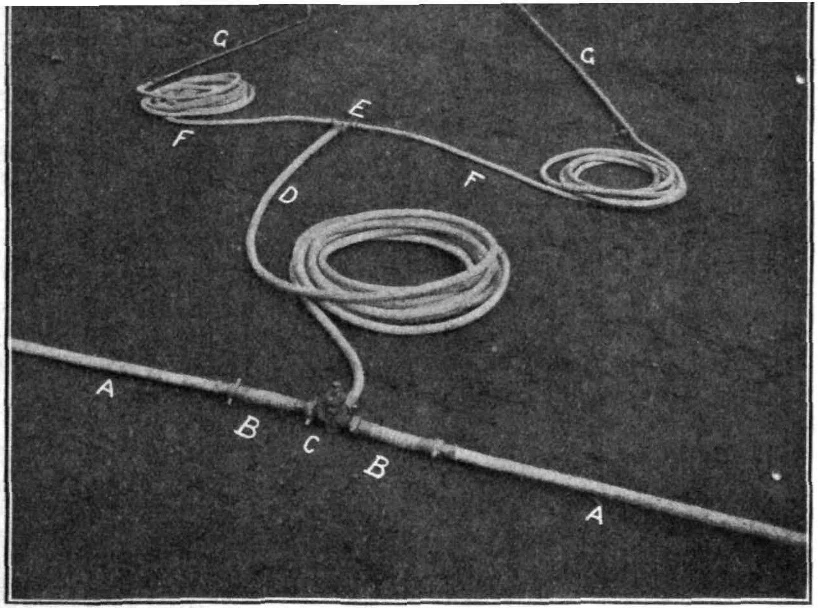
LIGHT POWER SPRAYING PLANT.
(Fitted with petrol engine.)

can be covered in a day, and the benefits derived from thus cleansing the trees and exterminating pests are such as to give a return of many times the first cost of the machine even in one season.

The same firm also make a very useful Knapsack sprayer which is specially constructed for dealing with all kinds of chemical washes. It has outside pumps and all its working parts are of gunmetal, so that there is nothing to get out of order, or become wasted away by the action of the chemical washes used.

They also make power-driven spraying plants, which are almost indispensable for large plantations. The engine may be either oil or petrol, as shown in the illustrations on pp. 579 and 582. The pumps are of varying capacities, dealing with from 700 to 2,000 gallons per hour; it will be noted that a stirring arrangement is provided so as to keep the wash thoroughly mixed.

The lighter types of these plants are usually provided with hose of a good length and are drawn about in the plantation and the wash conveyed to them in water-barrels. The heavier types are usually kept on the outside of the plantation and a system of piping used in connection with them to convey the wash to the required place as illustrated on p. 584. (The same apparatus can also be used to apply water to the plants.) The main consists of a series of light galvanized steel pipes having screwed ends



MESSRS. WEEKS' PIPE LINE AND CONNECTION FOR SERVING LARGE AREAS.

A, 15-ft. lengths of light galvanized steel tubing ; B, flexible connector ; C, three-way cock ; D, 60 ft. of main hose ; E, tee-piece at end of main hose ; F, lengths of hose leading to nozzles ; G, spraying branches and nozzles.

and connected by flexible connections. At intervals of every few lengths of pipe a three-way cock is inserted, to the outlet of which is attached the rubber hose. The three-way cocks can be set to shut the supply off entirely or open to the main or the hose only. The first length of hose branches into two further lengths, to the ends of which are attached the spraying branches and nozzles. The pipes of which the main consist are made of specially light galvanized steel tubing, so that a man can carry from four to six lengths at a time, and when the area at the end of the main has been sprayed the supply can be turned off at the nearest three-way cock and the piping out of use shifted to a new area.

With this system a large acreage can be sprayed (or irrigated) in one day, and the plant can also be used for ordinary pumping purposes for water supply, &c.

One word in regard to the Weeks' Patent "Multi-Spray" nozzle which the firm supplies with the machines. It is an exceedingly ingenious arrangement, which enables the grower to obtain any kind of spray he may desire, between the finest and softest mist and a long powerful drenching jet. It is adjusted by merely turning the cap and has clear passages, so that it is practically unchokable. The advantages of using this nozzle will be apparent, as it combines the uses of three or four of the ordinary pattern, and is adaptable for all purposes.

Messrs. Weeks and Son, Ltd., are also makers of road and tar spraying machinery, which are most valuable for laying dust around the factories or on roads generally.

The increased and increasing value of land demands, of necessity, greater care in the raising of crops, in order to maintain the ratio of profits on the returns. Consequently considerably more attention is now paid to the protection of crops from ravages of insect enemies and fungoid pests.

GENERAL NOTES.[1]

PESTALOZZIA AND POSSIBLE CURES.

A READER of the first edition wrote asking whether any remedy had proved successful in combating the disease *Pestalozzia palmarum*, discussed on pp. 277-278. To this we replied that well-fed trees on carefully cultivated lands should be able, as a rule, to throw the disease off should it attack them, but if badly attacked it is best to dig the trees up and burn them, as the trouble is one that tends to spread As a remedy when the trees are to be treated and not destroyed, Mr. Petch suggests the application of potash manure, and we would suggest in the face of this that kainit be chosen, since it has always been claimed that this is specially suited for coco-nuts and is comparatively cheap. Against this, however, a leading authority on potassic manures in the West Indies, writing to us about kainit *versus* muriate of potash, tells us: "I always recommend the latter out here in the West Indies for manuring, because of the great difference in price of K_2O. In muriate it amounts to

[1] We include these remarks as promised on p. 238.

3.27 cents per lb., while in kainit it is 4.88 cents per lb. In regard to the question of kainit for diseased coco-nut trees, there seems no reason why it should not do the same as common salt, and I always recommend it. We must keep in mind, however, that it is not practicable to use either kainit or any other chemical for rectifying improper physical soil conditions.

"The disease described as *Pestalozzia palmarum*, as well as all others that cause what is usually termed bud-rot, is nearly always prevalent on unsuitable soils, and practically absent where the natural conditions are favourable for the coco-nut palm. In the case referred to, the soil is unquestionably the cause of the trouble. As far as I remember I visited the place at one time, and was not very favourably impressed with the conditions. I tried kainit on trees similarly located in the Isle of Pines (off Cuba) three years ago, and it has since been reported that none of those trees died for two years; on the other hand, the dose was repeated about a year ago, but several of the trees have died since. The theory of placing a bag of salt in the heart of the trees as suggested on p. 238 in your book, seems plausible, provided the disease is carried by insects, and in that case of course, kainit would do as well; planters should remember, however, that it is not always the absence of potash or other plant foods that

causes or encourages the trees to become diseased, the trouble may be due to the soil being altogether unsuitable."

Another correspondent recommended trying Messrs. Newton, Chambers and Co's. proprietary preparation, "Izal," basing his suggestion on the following: "Since it is stated that the disease is due to an organism practically identical with *Bacillus coli*, then I should imagine that Izal would be an efficient disinfectant and preventive. I say this because Izal possesses a carbolic acid coefficient against this organism of about 14, which means that it is claimed to be fourteen times as efficient as pure carbolic acid. I feel certain therefore that if it was applied in a proper manner to the diseased parts of the palms, it should kill the organism causing bud-rot. The preparation can be mixed with limewash, and I think that if this were done, and the mixture applied to the bases of the leaves and spathes, it should in the first place prevent the plants becoming infected, and in the case of infected plants would probably kill the bacteria, and certainly would prevent it spreading to other parts.

"I do not anticipate that the mixture would injure the plant in any way, but never having used it on coco-nut palms, I cannot speak with certainty. I think, however, that it would be well to try its effect on diseased plants. With regard to the strength of the mixture, I would

suggest that 1 part of Izal fluid to 100 parts of limewash would be a suitable strength to start with. If this is not effective then put 1½ or 2 per cent. of Izal until you get what you want."

The Florescence and Fructification of the Palms.

Referring to the footnote on p. 253, where we mention the difficulty we experienced in ascertaining the length of time that passed between the first appearance of the bud and the gathering of the mature nuts on a coco-nut palm, Mr. L. C. Brown, Inspector of Coco-nut Estates in the Federated Malay States, to whom we applied for some information on the subject, was good enough to send us some notes on the matter. In these he told us, so far as he knew, he had a fixed idea that, from the time the bud appeared until the nut is ripe and ready to pick is twelve months. "On the same grounds," he continues, "I should say that from the first appearance of the spathe or stem, which carries the fruit, until the flower is in full bloom is at least a fortnight if not more, and until the fruit is actually formed on the stem a similar period, leaving about ten months to elapse before the nut matures. Climatic conditions, the soil in which the trees grow, &c., have a great deal to do with the question, and it is only by checking the results of a number of years and localities that any

definite solution of the question you have raised can be properly arrived at. A friend of mine who has had long experience with coconuts in the Federated Malay States, considers that, from the first appearance of the spathe until the fruit is fully matured, takes about thirteen months on an average, but agrees with me that it depends a good deal on climatic conditions." Mr. Brown contends that from the time of the first appearance of the spathe until *set* fruit can be counted would be about a month, and adds the interesting point that "pollination takes place to a certain extent before the actual full opening of the sheath, so that young fruit, which may or may not properly set, is observed half-formed as soon as the flower-spike comes into full view."

Dr. Fredholm (then) of Trinidad, but now at Porto Rico, wrote at some length on the various questions raised, as follows:—

"I noted with pleasure Mr. L. C. Brown's (Inspector of Coco-nut Estates, Federated Malay States) observations relative to the length of time elapsing between the appearance of the bud and the ripening of the fruit. These correspond pretty closely with my own. He gives an average of twelve months, and his correspondent thirteen months. In my articles (in the *West India Committee Circular*) I have written, 'That in the coco-nut palm there is an appreciable difference between the time of the ripening of the fruit and of

the seed, has already been discussed. When the fruit is nearing maturity it changes from green to yellowish, brownish or reddish. In this respect there is considerable variation. The same is the case as regards size and shape of fruit, size and form of endocarp, size of seed, and thickness of husk, shell and meat. These variations are fully discussed in my chapters (being part of the series of articles mentioned above) on cultivated strains. Nor is the time which it takes the fruit to mature always the same. This is mainly dependent upon the vigour of the palm, the seasons, the character of the soil and the habitat. As an average period, eight to ten months may be given.' This represents the time from fertilization to ripeness; add to it six or eight weeks for the development of the inflorescence, and it is seen that we are in pretty near agreement.

"But when you state that 'pollination takes place to a certain extent before the actual full opening of the sheath, so that young fruit, which may or may not properly set, is observed half-formed as soon as the flower-spike comes into view,' then you are wrong. You have evidently mistaken the female flower bud for the young fruit (the fertilized ovum). In this plant in-breeding is so exceptionally well guarded against that it is well-nigh impossible, the pollen grains and the ovules of one and the same inflorescence never arriving at maturity simultaneously. On this point I

write, in my articles, as follows: 'In-breeding or close-breeding is guarded against as much as possible in nature. It is prevented, in the case of the coco-nut palm, by a difference in the time of expansion of the male and female flowers on the same spadix, and as a palm rarely has more than one inflorescence at a time with open flowers, the pollination of the female flowers is generally brought about by pollen from the staminate flowers of another palm. Thus cross-pollination is the rule. The pistillate flowers do not expand before the staminates of the same spadix have shed their pollen and fallen off. Until that time the gynæcium remains completely covered by the perianth leaves, and fig. 3[1] in my articles shows a spadix with pistillate flowers expanded, and it will be noted that all the male flowers have already dropped.' Compare fig. 23A.[1]

"Those of your readers who hope that in my notes I have given details of the formation of the bud, the flower, the nut, &c., and the time each takes to complete each of these stages, will find, I hope, that I have not neglected these important subjects. The first four chapters are devoted exclusively to the morphology of the palm, and I have endeavoured to treat of the matter as extensively as the average planter's patience will permit."

[1] See *West India Committee Circular*, from August 27 and subsequent numbers, published by the West India Committee, 15, Seething Lane, London, E.C.

The Cost of Establishing an Estate in the Federated Malay States.

Regarding the cost of establishing company-controlled estates in the Federated Malay States, it is useful to note that according to the report of the Selangor Coco-nut Co., Ltd., any idea of opening coco-nut land at £20 an acre is nowadays absolutely out of the question, if sound and lasting work is to be done. This company estimates that their coco-nut property will cost them £35 to £36 per acre, due to some extent to the isolated and uninhabited nature of the country. Mr. Kelway Bamber, who recently gave expression to most optimistic opinions concerning the future of coco-nuts in the Malay Peninsula, thinks that £34 to £40 would be a fair price per acre for bringing a coco-nut estate into bearing, or, if there is ample labour to start with, £25 to £30 might do. Concerning the profits, some interesting figures were given by the Chairman at the meeting from figures compiled by Mr. Dale, who, in the seventh year, with one picul of copra selling at $10—a low price nowadays—says that a profit of 4½ per cent. may be anticipated with 30 nuts to the tree. In the eighth year 50 nuts per tree and 14 per cent. (profit), and after that 55 nuts per tree giving 16 per cent. If the selling price of copra remains at $13 per picul as now, he estimates profits of 9 per cent., 24½ per cent.,

and 27½ per cent. respectively; and, according to the Chairman, it would appear that even at £50 per acre coco-nuts are a better investment than anything a stockbroker at home would recognize as absolutely safe.

According to the latest official reports, coco-nuts are steadily increasing, principally in Perak and Selangor, though the amount of copra exported last year was smaller than in the year before, owing to the greater local consumption. Lower Perak at present contains 30 per cent. of the total coco-nut area of the country. An interesting feature of the industry is the introduction on a large scale of the dwarf or King coco-nut (*Nyor gading*), which is being tried in the Coast district of Negri Sembilan. Two estates, Sungei Nepah and Chuah, now have 500 acres of this variety under cultivation. The young trees, which are planted 20 ft. × 24 ft., giving 90 to the acre, are doing very well. Preliminary expenses have been rather heavy owing to the difficulty in procuring seed. On the other hand, the palms should come into bearing in about four years, which means not only a shorter time and less expense on upkeep before revenue is obtained, but also a quicker return on money invested. It remains to be seen whether these advantages and the probable higher yield of nuts per acre will compensate for the greater expense in husking, &c., per lb. of copra obtained.

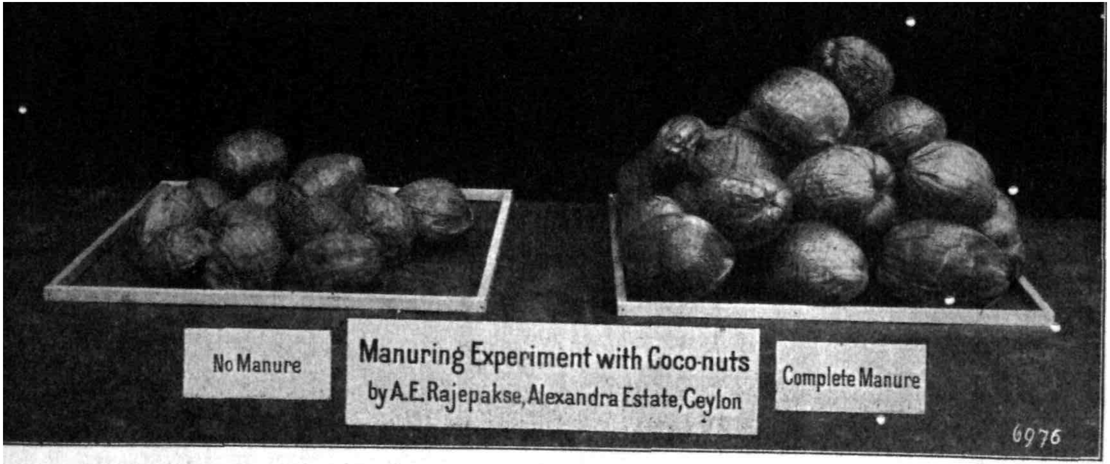
The Manufacture of Edible Coco-nut Butter.

'According to the United States Consul at Carlsbad (Austria), says the *Indian Trade Journal*, most of the coco-nut butter manufactured in Bohemia is made of Cochin China or Indian copra, which is received in large wooden tuns. The dried copra is sliced, and the fat is extracted by oil presses, quite a simple process. This raw oil contains soap fats and does not have a pleasant odour. It is placed in large tanks and the first step in the refining process is the addition of powdered chalk, which absorbs the soap fats and settles to the bottom of the tank. The oil on the surface is pumped into another tank, passing through four or five filters as the second step in the refining process. It is then forced into a tank heated by steam pipes to about 270 C. (518° F.). This process continues until the oil is as clear as crystal and begins to bubble. It is then pumped into an automatic weighing apparatus and run into the moulds, where it is allowed to cool. The tablets or cubes are removed to the packing table. Part of the oil is run into various sized tubes and is also placed on the market in this form. The soap fats, combined with the chalk, are treated with sulphuric acid, which dissolves the chalk, leaving the fats floating on the surface of the solution. These are drawn off into tubes and are sold to manufacturers of soap. The trimmings of the copra slices are

made into a powder, and command a good price as fodder for cattle and pigs. The coco-nut fat is white, but when manufactured into butter is coloured to resemble oleomargarine. Sesame oil is added to make the product more pliant. Coco-nut butter keeps well either raw or refined and does not spoil for months, even in warm weather. It is claimed that the ordinary consumer cannot detect the difference between this butter and oleomargarine. Six or seven years ago the output of coco-nut butter in Austria was about 40 tons a day. It is now approximately 300 tons. The price has increased from $18.25 to $26.40 ($ = 2s., or actual value about 1s. 9d.) for 200 pounds, and the factories, it is claimed, cannot keep up with the demand. What the output of edible butter must be elsewhere, as around Marseilles, &c., it is difficult to realize if this is what Austria requires.

The Latest Manuring Experiment.

Confirming the report on coco-nut manurial experiments conducted in Ceylon by Mudaliyar A. E. Rajepakse, Alexandra Coco-nut Estate, Jaela (see p. 316, and elsewhere), the accompanying photographs illustrative of the results of 1912, which have only recently come to hand, will be found of especial interest. Although for various reasons the yields were by no means so large as in 1911, fifteen nuts per tree being got on an average from the

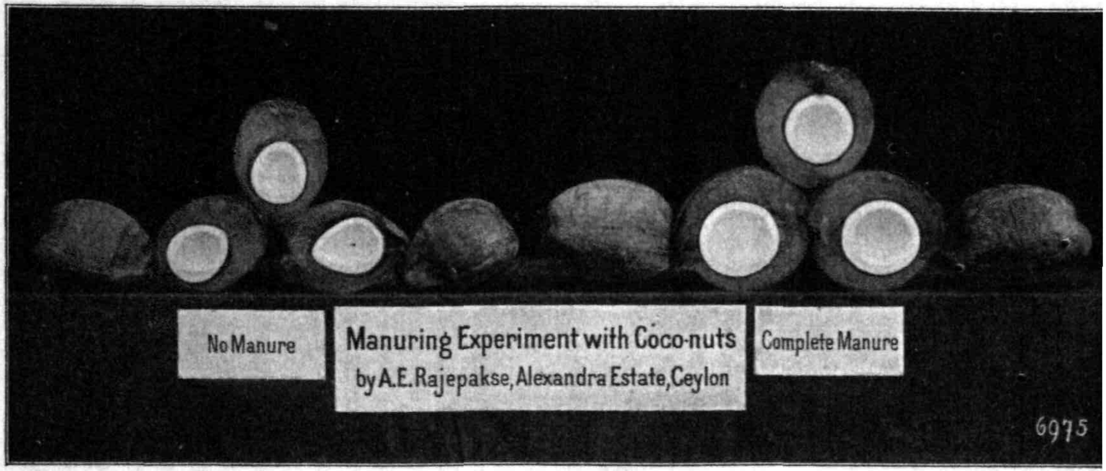


EFFECT OF ARTIFICIAL FERTILIZERS ON COCO-NUTS.

Typical Yield from Unmanured Tree as compared with result from Complete Manuring.

No Manure. (Four baskets Cattle Manure.)
Average yield—15 Nuts per Tree.

Complete Manure :—
15 lb. per Tree { 6 lb. Bone Meal, 3 lb. Castor Cake, 2 lb. Fish Manure. 3 lb. Kainit, 1 lb. Sulphate of Potash.
Average yield—37 Nuts per Tree.



COCO-NUTS IN SECTION, 1912.

Showing the effects of Manuring in increasing the Size of the Kernels.

no-manure plot and thirty-seven from that which had been fully manured, the results, nevertheless, speak more strongly than ever in favour of the use of artificial fertilizers. The illustration on p. 598 shows side by side a typical yield from a manured tree compared with a typical yield from an unmanured one, the number of nuts in the former being two and a half times that in the latter, and the individual specimens at least half as large again. It must be noted, moreover, that this increase in size is not a mere increase in husk and shell, for the flesh, as indicated by the photograph reproduced on p. 599, has been more than proportionately increased.

Yields.

Some of the critics of the first edition of this book have complained that in speaking of forty nuts only per palm we have been too conservative; we, on our part, consider we have been over sanguine. During the past twelve months it has been easier to obtain reliable statistics, and whilst none of the published returns of the large estates showed an average of even forty nuts, many expressed disappointment at the average received per palm, and rightly explained that drought was the cause, but some had no excuse to offer; the deficiency as compared with the estimated yield was there and no reason was given. Under the heading of "'Ware Coco-nuts," the

Madras Mail recently told us: "We are mindful rather of the repeated failure of coco-nuts to justify the anticipations indulged in regarding them by sanguine directors. Take, for instance, the case of the K . . . . Coco-nut Estate Company, a Ceylon rupee undertaking, which, according to the *Investors' Chronicle*, offers another instance as to the unremunerative character of coco-nut planting. It owns 18,550 trees in bearing after eleven years' existence, equivalent to 206 acres, and last year's crop, which was well in excess of the estimate, was 250,919 nuts, or under fourteen nuts per tree! J . . . , a Malayan undertaking, after three years of intensive cultivation with coco-nuts grown under ideal conditions, has had to reduce its official estimate for 1913-14 to 750,000 nuts, against 1,000,316 obtained in 1910-11. S . . . . . , which anticipated 300,000 nuts for 1912-13, but harvested only 173,734 nuts, has now reduced its official estimate for 1913-14 to 200,000 nuts. These estates are under first-class management, and these facts, says our contemporary, "should serve to warn the investing public against those who are privately touting for subscriptions to coco-nut companies. The Colonial Secretary would never have issued his warning against the coco-nut schemes of ex-Government officials unless there had been very strong reason." We include these remarks, not to frighten or discourage would-be planters, but to warn them of what to expect; and, above

all, to show the need there is to leave no stone unturned to keep the estates up to "concert pitch," as far as it lies within their power to do so.

The *Madras Mail* also has something to say on this, but, be it noted, ends up with a word of encouragement for the careful and leave-nothing-to-chance man." "The fact is," we are told, "that coco-nut cultivation is exceedingly complex. Coco-nut palms require intensive cultivation and high manuring, and they are menaced by a number of insect and fungoid pests. In any case it is said to be courting disaster to open any large area and plant it with these palms in one year, if there is any uncertainty as regards labour. The planter who neglects his coco-nut plants for a few weeks in the Monsoon and lets them get covered with weeds, as at times coffee, tea and rubber trees are covered, will find the few that remain alive scarcely worth troubling about. Such, at any rate, seems to be the view of men who have had experience of this product. It is admitted, however, that if the coco-nut planter is able to go and have a look at each plant almost every day of the week, as does his Indian *confrère*, we believe, it is quite likely that he will obtain the best results."

Prices of Coco-nut Products, &c.

The following were the comparative values of the undermentioned crops in November, 1913; readers should compare them with

those of April, 1912, given on pages 17-19, and note the rise in values that has taken place since then.

According to Messrs. Mordaunt Bros., Cochin coco-nut oil was hardly mentioned at the latter part of October, and is still an idle market, whilst Ceylon oil has remained steady, being quoted at 45s. 6d. to 46s. c.i.f. per cwt. on October 25, against 45s. 3d. to 45s. 6d. on November 8, when buyers were offering a fraction lower. Palm kernel oil moved upwards during the same period from 43s. 9d. to 44s. 3d. cwt. f.o.b. Hamburg up to 45s. f.o.b., or at least that was the quotation. Pressed oil was unchanged and steady at 44s. 3d. f.o.b. London for November-December, with buyers very near that price.

Copra steady, unchanged. Malabar, October-December, £32 5s. sellers, and January-March, £32 2s. 6d. Hamburg. Ceylon, September-October, £32 2s. 6d. sellers, and October-November, £32 2s. 6d. Hamburg. Java, July-September, £31 7s. 6d. sellers; August-October, £31 2s. 6d.; October-December, £31; January-March, £30 12s. 6d. Holland, Hamburg, and Bremen. Macassar, July-September, £31 2s. 6d. buyers; August-October, £30 17s. 6d., and October-December, £30 17s. 6d. Holland, Hamburg, and Bremen. Singapore, August-September, £31 2s. 6d. buyers; August-October, £31 2s. 6d., and November-December, £31 2s. 6d. Hamburg.

Cebú, August-September, £31 10s. buyers, and August-October, £31 2s. 6d. Marseilles. South Sea Island, August-September, £30 12s. 6d. paid, and September-October, £30 12s. 6d. buyers, London. F.M. Straits, October-November, £30 12s. 6d. buyers Marseilles. October-November, £30 17s. 6d. sellers Odessa. Manila, August-October, £30 15s. buyers; October-November, £30 7s. 6d., and October-December, £30 Marseilles. Mixed no Padang, August, £30 15s. buyers, and August-September, £30 15s. Marseilles, all c.f. and i., delivered weight.

Coco-nut Oil.—Ceylon spot, £48; October-November, £46 2s. 6d. c.i.f.; November-December, £46 2s. 6d. c.i.f. Cochin spot, £60; October-November, £49 10s. c.i.f.

Regarding coco-nut oil, Messrs. Goodlake and Nutter report that the market is firm with an upward tendency, and there has been a fair amount of business during the week for c.i.f. New York. For Ceylon, November-December, December-January, and January-February we quote 46s. 9d. There is not so much inquiry for London except for near oil, and then below sellers' ideas. We quote 45s. 7½d. to 45s. 9d. November-December, January-February. Cochin oil is not much in demand. We quote 50s. 3d. October-December shipment. Palm kernel oil is much firmer, and a fair amount of business done at 46s. 6d. for near oil, but sellers now asking 46s. 9d. to 47s., with buyers

of January-March at 46s. 7½d., and sellers 46s. 9d. f.o.b. Hamburg. Pressed: There is nothing doing. Spot prices: Ceylon, £48 to £50. Cochin, £58 to £60.

Prices generally on November 8 ran as follows :—

Palm oil (*Liverpool*) : Per cwt.	1913	1912	1911
Lagos ...	33s. 6d. to 33s. 9d.	30s. 6d. to 30s. 9d.	32s.
Benin ...	30s. to 30s. 3d.	27s. 3d. to 27s. 6d.	30s.
Congo ...	27s. 3d. to 27s. 6d.	25s. 6d. to 25s. 9d.	28s.
Bleached ...	34s. to 35s. 6d.	32s. to 32s. 6d.	34s.
Clarified ...	30s. to 31s. 6d.	28s. 6d. to 30s.	30s. 6d.
Palm kernel oil	44s. 9d. to 45s.	36s. to 36s. 6d.	38s. 6d. to 40s. 6d.
Coco-nut oil :			
Cochin ...	60s.	47s.	49s. 6d. to 50s.
Ceylon ...	48s.	40s.	45s. to 46s.
English pressed	44s.	37s. to 37s. 6d.	38s. 6d.
Copra oil :			
Ceylon ...	None	39s.	45s.
Cochin ...	54s.	43s.	47s.

According to the *Public Ledger* of November 11, prices ruled as under :—

Soya Oil.—Hull: Naked extracted, spot, £26 2s. 6d.; November-April, £26. Oriental (in cases), October-November, £25 15s. c.i.f.; November-December, £25 15s. c.i.f.; December-January, £25 15s. c.i.f.; January-February, £25 17s. 6d. c.i.f.; February-March, £25 17s. 6d. c.i.f.; March-April, £25 17s. 6d. c.i.f. Antwerp.

Palm Oil.—Lagos on spot, £35 10s.

Palm Kernel Oil. — November-December, £45: January-March, £45 f.o.b. Hamburg.

Soya Oil Beans. — Parcels Harbin spot, £8 10s. Hull; December-January, £8 2s. 6d.;

January-February, £8 2s. 6d.; February-March, £8 2s. 6d.

Linseed Cakes.—London made, £7 12s. 6d. to £7 15s.

Cotton Cakes.—London made, £5 10s. to £5 12s. 6d.

Coir Fibre.—Cochin—A small turnover, values maintained. Ceylon—Little business doing, values a shade in sellers' favour.

Coir Rope.—No business to report.

Coir Yarn—			
Common to good Cochin Roping Dholls	£18	to	£22
Common to good ,, ,, Bales	18	,,	21
Common to fair ,, Weaving ,, ...	13	,,	22
Fair to good ,, ,, ,, ...	23	,,	26
Good to extra ,, ,, ,, ...	27	,,	34
Common to fair Ceylon Ballots	16	,,	20
Fair to good ,, ,, and Bales	22	,,	24
Good to extra ,, ,, ,,	25	,,	29
Coir Fibre—			
Cochin, common	18	,,	20
Fair	21	,,	24
Good	26	,,	28
Ceylon, short to fair	6	,,	8
Clean long	11	,,	14
Coir Rope—4½ to 6 inch	15	,,	18
2½ ,, 3½ ,, ...	22	,,	24
1½ inch	23	,,	24

Kapok and Coco-nuts.

As promised on p. 199, and also because several experts and planters have coupled kapok and coco-nuts together as suitable crops in some areas, as in East Africa, the Philippines, and elsewhere, we are including

in this book the following notes, especially as a good deal of space has been devoted of late to the subject. We will begin by saying that we have just received a forty-paged brochure on "The Kapok Industry,"[1] from the Department of Agriculture, Manila, Philippine Isles. Mr. Saleeby, Chief of the Fibre Division, and author of the book, claims that the natural conditions in those islands are on the whole entirely favourable for the cultivation of this crop, and with the increased demand for the floss for upholstery and life-saving appliances remunerative prices are looked for. The climatic conditions which directly affect the growth of kapok, and the development of its fruit and floss, are three, viz., the degree of temperature (the tree requires a warm climate), the amount of rainfall (the tree does not require a large amount, nor an even distribution of rainfall), and the absence of strong winds (which injure the long, heavy, horizontal branches).

The seeds yield about 20 per cent. of oil, and the cake can be used with advantage as cattle feed and as a fertilizer. The weight of the seed is, roughly speaking, double that of the floss, and on the basis of rates ruling at

[1] "The Kapok Industry," by Murad M. Saleeby, being Bulletin No. 26, issued by the Bureau of Agriculture, Manila, Philippine Isles, with many illustrations showing how to plant, divergencies in size of fruits, &c. No price mentioned. Postage would cost 1½d.

the close of 1912, or the beginning of this year, Mr. Saleeby estimates that a hectare of land in the Philippines, planted to kapok under seven years of age, will yield 800 to 900 kilos of seed per year, valued at P. 28 to P. 31.56 (P. = 2s. 0½d.). At the same time a very wide divergence is encountered in yields, both in the number of pods to the trees (350 to 400 and even 600 pods in extreme cases) and the yield of floss per pod (150 up to 300 pods = 1 kilo floss, with a probable average of 230 pods to the kilo). The judicious selection of seed from uniform pods will undoubtedly increase the average yield of floss in the pods. On the above basis a hectare planted in kapok and containing 280 trees (about 110 to the acre) ought to yield 98,000 to 112,000 pods, which at the rate of 230 pods to the kilo will yield 420 to 480 kilos of clean kapok per year. From the seventh to the tenth year a hectare should yield about 640 kilos. The harvesting is troublesome; many let the pods ripen and drop, but this is not good. Owing to the weakness of the branches, especially between their middle bend points, they are practically inaccessible, and the pods can best be gathered by knives attached to long poles. To know when the pods are ripe requires experience. Before ripening they are of a light green colour, with a smooth surface, whilst as soon as they ripen they turn light brown, and the surface becomes somewhat

wrinkled. We noticed in November (1913) that a Colombo (Ceylon) firm dealing in silk cotton (kapok) was publishing the following notice in the papers: "We are prepared to buy kapok seed in any quantity at R2.50 (3s. 4d.) per cwt. net, delivered free Colombo railway station. There is practically no difference between kapok and cotton seed and we are paying the same price for both. As regards kapok lint, for uncleaned stuff, *i.e.*, the pods with only the outer husk removed, if of good quality and dry we can give R9 (R = 1s. 4d.) per cwt. net delivered f.o.r. Colombo. We are buying good white well-cleaned (free from seed) kapok lint at R33 (44s.) per cwt., or about 5d. lb. net delivered free Colombo railway station."

Mr. Saleeby in his book tells you all the planter wishes to know; we, unfortunately, cannot do so. We can only say that, according to this authority, and speaking of the Philippines, kapok is propagated from cuttings or from seeds. The use of cuttings is by far the easier method and is, therefore, more commonly practised. If cuttings are used these are usually obtained from the branches of trees in the neighbourhood. Trees reproduced from cuttings generally yield a crop six to twelve months earlier than those reproduced from seed, and the great majority of the kapok trees in the Philippines are reproduced from cuttings.

Yet, we are told, propagation from seed is, on the whole, the better method. The seeds germinate rapidly, and retain their vitality for a long period ; in addition the trees reproduced from seed are generally healthier, more productive and more resistant to strong winds, and attacks from white ants and other pests than are those reproduced from cuttings. If seeds are used, they should be selected from trees which are more than five years old, of rapid growth, and of early and uniform fruiting habits ; also see that they bear large numbers of pods, with a comparatively thin husk, and a large quantity of floss of good quality. Having gathered the pods, still look them over and avoid those which contain fuzzy floss of a naturally dull colour, and seeds below the average size to a marked degree.

As regards soil, the tree flourishes in a wider range than most other tropical plants of economic importance. The tree cannot stand frost, it does best at an altitude below 500 metres and in a well-weathered volcanic soil. It is probably due to this fact that the best grade of Java kapok is produced along the foothills of the Moeriah Mountains in the extreme eastern part of the Semarang Residency.

'Ware Deforestation.

Both India and Equatorial Africa are important centres for the production of those economic products which flourish best within

the Tropics. Already important exporters of such crops, their output can, and we believe, so long as their water supplies are adequate, will be doubled at least, with the improved system for cultivation and the more modern methods of preparing the crops for market that the Governments through their various Agricultural Departments are striving to introduce. For the Agricultural Departments, however, to be successful there must be no doubt about ample water supplies being always available; without that nothing can live, neither natives, stock, nor crop. This being so, we feel it is well to devote the last words of this book to warn our readers, who will, we believe, include most of the Directors of Agriculture, as well as the leading members of the staffs under them, against allowing excessive deforestation of the lands under their control, and particularly of exposed ridges and elevated headlands, as indiscriminate clearances in such places cause a serious diminution in the rainfall, which reacts on the water supply from the rivers, springs, &c., feeding the estates, as well as those working on them. Such effects also are by no means confined to the immediate area surrounding the lands being cleared, but can and do, as we show further on, extend far and wide—even to other continents. This being so the authorities owning the lands or having the control of their development must look around and ahead before deciding which

lands they can sell for planting and which should be reserved as shelters and rain centres for the benefit of the people under their charge. It is an international as well as an inter-departmental matter, as we pointed out at the Brussels Congress in 1910, and afterwards in book form, when we claimed that "when opening up fresh tropical forest lands, or laying down new estates, the authorities should take quite as stringent precautions to safeguard the health of the trees, plants, &c., as they are expected to do when building a new city."[1] Forest belts not only assure water supplies, but reserve them as they come and so equalize them for future use, as Paris has learnt to her cost since the woody uplands that feed the Seine have been denuded and caused that river to flood the gay city to a ruinous extent at one time, and then to run so dry at another that it was easier (if not cheaper) to wash in soda water than go to the standpipes for their supplies.[2]

We conclude, therefore, with this warning, as we believe the economic resources of both India and Equatorial Africa will be greatly developed during the coming century, and (this

[1] "See Notes on Soil and Plant Sanitation," Preface, p. xviii, and especially the section devoted to Protective Belts, pp. 49-67, in which the causes of the treeless veldts in South Africa and of the Sahara up north, as well as soil deterioration in Carolina, U.S.A., are fully discussed.

[2] See *Tropical Life*, August, 1911, p. 153.

being agreed) because we are told[1] that the climatic conditions of India are unique among those of the great countries. The reason for this can be spelt in seven letters, namely by the word "monsoon." In India we have a tract of country as vast as a continent, inhabited by 316,000,000 industrious but comparatively poor folk, whose support is dependent mainly upon the industry of agriculture. It is stated that the prosperity of no less than seven-eighths of this vast population hangs more or less upon whether the seasonal harvest be favourable or not. By one of the most stupendous miracles of Nature, the source of the rainy weather is derived *from the heart of Africa*. The peasant of India owes his very existence to rain clouds called into being in the former country, and despatched thence on their beneficent mission to discharge moisture for the fertilization of Indian crops. Sweeping across divided seas, and up either flank of India to the head of the Persian Gulf on the one hand and the Bay of Bengal on the other, the monsoon holds in the hollow of its hand the life or death of no small proportion of India's many inhabitants. Rain too little or too heavy, or at the wrong period, can turn—and often in past history has turned—plenty into dearth, health into pestilence, and a comfortable subsistence into fierce famine.

[1] See London *Daily Telegraph* of November 20, 1913, p. 3, column 1. First notice on the "Report of the Royal Commission on Indian Finance."

In face of the foregoing remarks, so long as men continue to denude the surface of the earth of its forest-lands, precautions must be taken far ahead to see that in opening up the heart of Africa to the ploughshares of European enterprise ample areas are left untouched, lest in clearing them we carry death and desolation to India, and so in benefiting the individual in one continent we harm the multitude in another. This warning at the same time does not by any means apply only to India and Africa; over-zeal in clearing forest-lands has brought, and will yet bring trouble in many centres, so let us see that the harm in future is reduced to the smallest possible minimum by omitting no precautions when settling lands or developing new areas.

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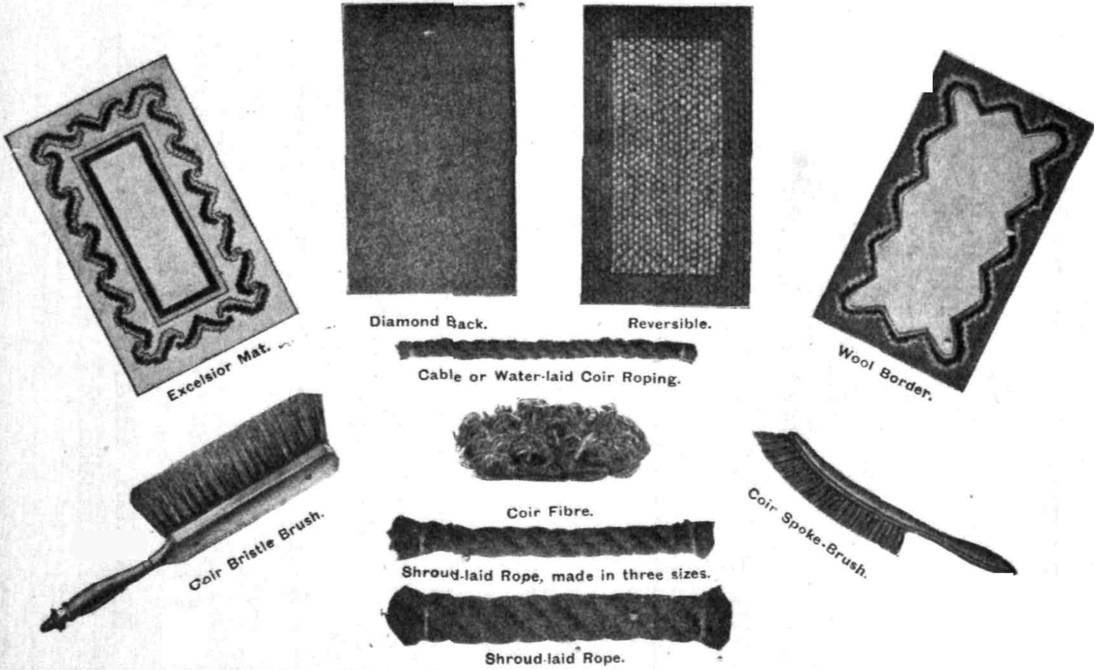

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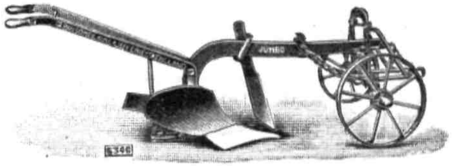

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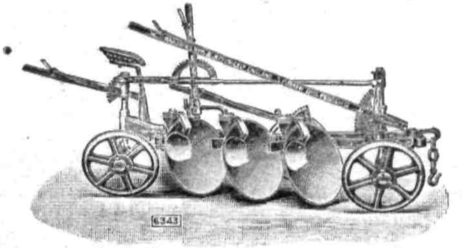

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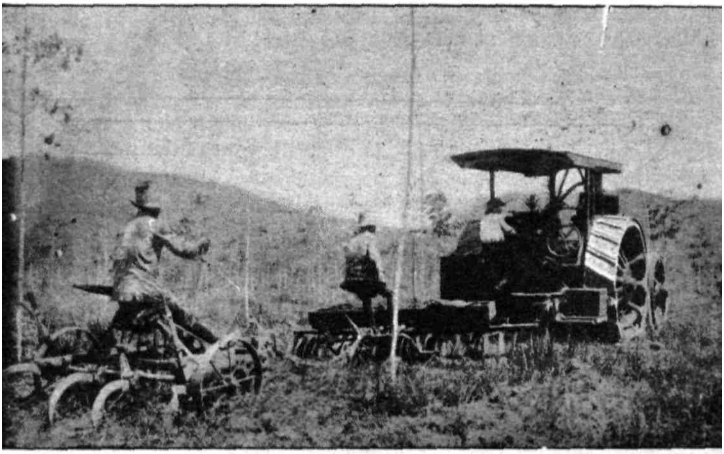

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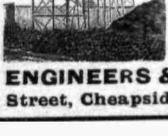

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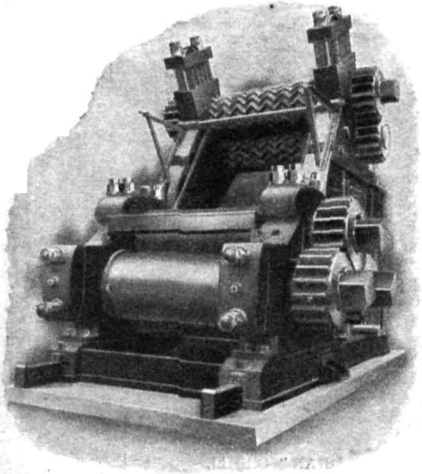

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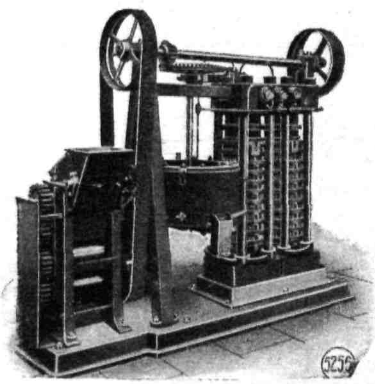

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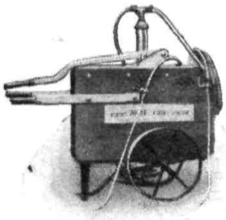

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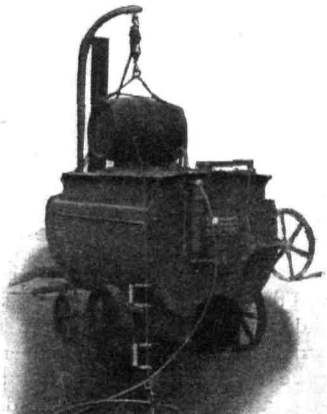

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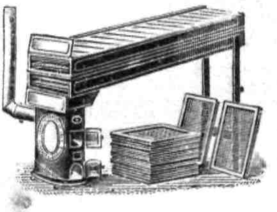

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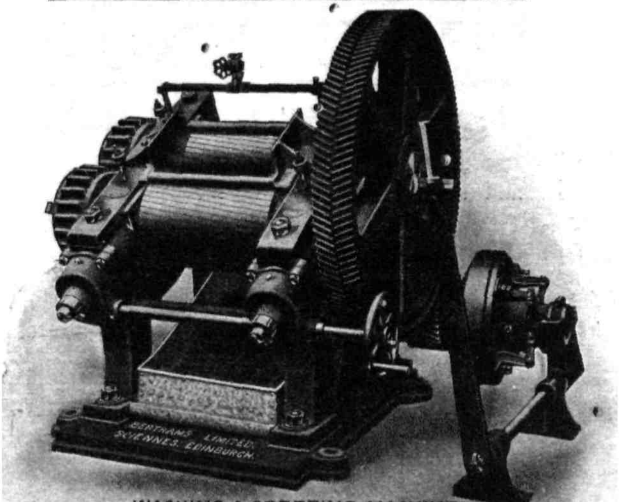

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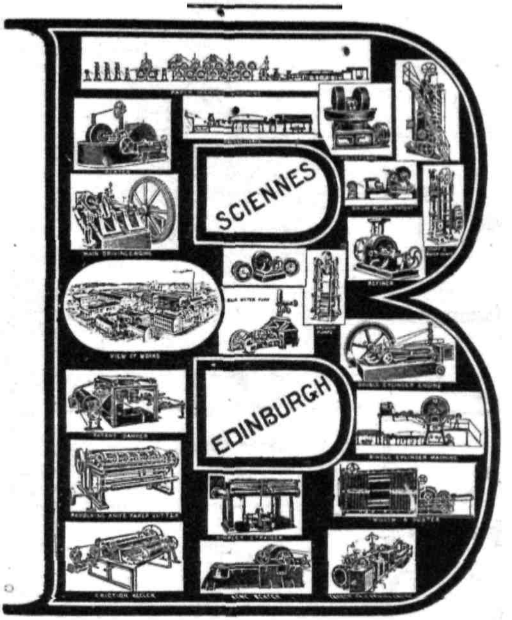

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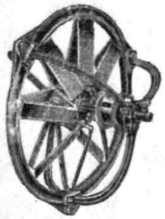

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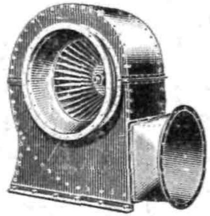

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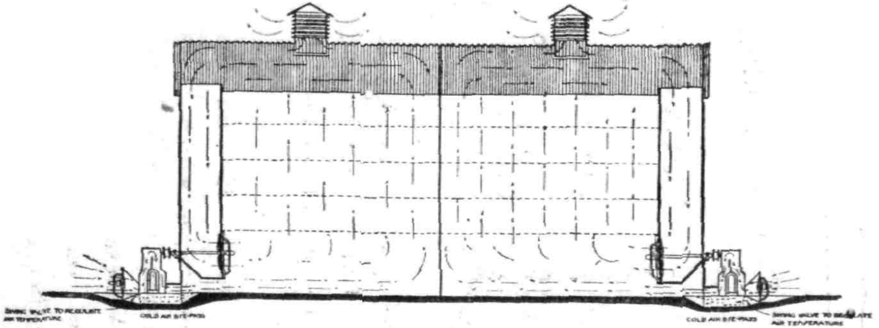

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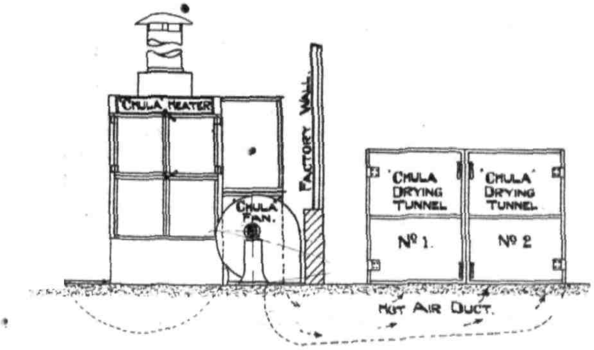

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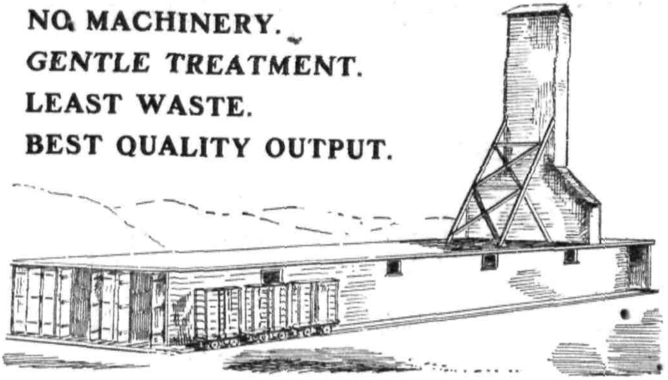

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